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FRASER VALLEY SYSTEM REINFORCEMENT PROJECT

TECHNICAL REPORT

June 1991

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TECHNICAL REPORT

for Transmission Engineering

for Stations Engineering

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EXECUTIVE SUMMARY

Reinforcement of the major transmission/ substation facilities in the south central and eastern Fraser Valley (includes supply to the Fraser Canyon) is required by about the mid 1990s to meet the increasing demand for electricity in that area. The area encompasses the Langley, Matsqui, Abbotsford and Chilliwack municipalities in the south central Fraser Valley and east to Hope and north to Boston Bar in the Fraser Canyon.

To provide this reinforcement, it is proposed that a 500 kV substation with a transmission connection to one of the 500 kV transmission lines passing through the southern Fraser Valley be constructed. Three possible substation sites were identified for development of the 500 kV substation. All three sites are adjacent to existing 230 kV substations. These existing substations are McLellan Substation located in Surrey near Langley, B.C., Clayburn Substation located in Matsqui near Abbotsford or at Atchelitz Substation located in western Chilliwack.

New equipment installed as part of a 500 kV substation would include four 500 - 230 kV single phase transformers each rated at 200 MVA including one spare, three 500 kV circuit breakers, two 230 kV circuit breakers, 500 and 230 kV disconnect switches, potential devices and surge arresters as required and additional protection, control and communications. Station equipment would be controlled remotely from Burnaby Mountain Control Centre as well as locally. At least one new system of 500 kV protection would be required because the in-out transmission tap effectively creates a new line. In all three cases varying degrees of compact substation designs have been proposed to overcome site conditions which do not allow a conventional 500 kV substation layout.

Each of the existing substation sites is located adjacent to the main 500/230 kV transmission corridor (2 - 500 kV circuits, 5L81 and 5L41, and 1 - 230 kV circuit, 2L75, 2L76, 2L77 and 2L78) which traverses the southern Fraser Valley. The proximity of the existing stations to the corridor will therefore make any transmission connection relatively short. A 500 kV transmission connection would be required to the existing Circuit 5L41 and would involve the construction of an "in and out" loop, which would be up to 0.5 km in length. The 500 kV transmission connection would be made to Circuit 5L41 for voltage stability and operational reasons. To provide lightning protection for the substation, overhead groundwires will be added to Circuit 5L41 for approximately 1 km on either side of the loop connection on 5L41. Extended outages will be required on 5L41 over a period of several weeks to construct both the loop connection and to add overhead groundwires .

The proposed in-service date for the new substation is October 1994. To meet the 1994 in-service, design for the substation would commence by the fall of 1991. Further design and

equipment ordering would continue in 1992 and civil and electrical on-site work would occur in 1993 and 1994, respectively. Construction of the 500 kV transmission loop would occur in 1994.

The technical evaluation made up of criteria such as design, construction, maintenance, operation, future considerations and cost indicates that the Atchelitz alternative, comprising a new 500 kV substation located immediately north of the existing 230/69/25 kV substation site on property which would have to be acquired by B.C. Hydro, together with a very short 500 kV transmission line tap on existing B.C. Hydro right-of-way, would be the best overall choice from a technical viewpoint. The choice of Atchelitz is closely followed by the Clayburn substation alternative which requires a transmission line loop approximately 0.5 km in length. The McLellan substation alternative is a distant third.

The estimated cost at completion for the 500 kV substation and associated transmission located at Atchelitz Substation is \$28.9 million including inflation, corporate overheads and interest during construction. For the Clayburn substation alternative the estimated cost at completion is \$30.5 million while the McLellan substation alternative is substantially higher at \$39.0 million:

1.0 INTRODUCTION

1.1 Purpose of the Project

Reinforcement of the major transmission/ substation facilities in the south central and eastern Fraser Valley (includes supply to the Fraser Canyon) is required by about the mid 1990s to meet the increasing demand for electricity in that area. The area encompasses the Langley, Matsqui, Abbotsford and Chilliwack municipalities in the south central Fraser Valley and east to Hope and north to Boston Bar in the Fraser Canyon.

Most of the electricity to the south central and eastern Fraser Valley is transmitted on a 230,000 volt (230 kV) transmission/ substation system supplied primarily from Rosedale Substation near Chilliwack B.C. on the east and Ingledow Substation in Surrey B.C. on the west. Rosedale Substation connects to Bridge River Generation west of Lillooet, and to Wahleach Generating Station east of Chilliwack. A large majority of the energy transmitted along the 230 kV line through the southern Fraser Valley is from Bridge River generation. The reliability of the system becomes tenuous if one of the sources on the west or east is lost. As we approach the mid 1990s the increased demand primarily in the south central Fraser Valley, is expected to fully utilize and exceed the capacity of the existing system.

The proposed reinforcement is anticipated to be required by the fall of 1994.

1.2 Project Description

This project comprises the construction of a new 500 kV substation to be located adjacent to the site of one of the three existing 230 kV substations, located in the southern Fraser Valley and a short 500 kV transmission line connection between the new substation and the existing 500/230 kV transmission corridor. This project will provide additional electricity capacity in the south central Fraser Valley.

Existing major transmission lines and substations located within, and passing through, the south central Fraser Valley are outlined on Figure 1. These lines and substations operate at 500,000 volts (500 kV), 360,000 volts (360 kV), 230,000 volts (230 kV) or 69,000 volts (69 kV). From the transmission voltage

substations, distribution voltage lines (25,000 volts and less) service the valley.

The major transmission corridor in the south central Fraser Valley runs east to west from Rosedale to Ingledow transmitting electrical energy from the large generation plants in B.C.'s Interior. This corridor presently contains two steel lattice tower 500 kV lines named circuit 5L81 and circuit 5L41 and a single steel lattice tower 230 kV transmission line (circuits 2L75, 2L76, 2L77 and 2L78). Figure 2 shows a cross section of this corridor. Circuits 5L81 and 5L41 originate at the Nicola Substation near Merritt and Kelly Lake Substation near Clinton, respectively. The 230 kV line located on the south side of the corridor supplies electrical energy to the south central Fraser Valley between Ingledow (500/230/69 kV) Substation and Rosedale (360/230/69 kV) Substation to the following substations:

1. McLellan (230/25 kV) Substation located near Langley, in Surrey connected to circuits 2L75 between Ingledow and McLellan and 2L76 between McLellan and Clayburn.
2. Clayburn (230/25 kV) Substation located north of Abbotsford, in Matsqui connected to circuits 2L76 between McLellan and Clayburn and 2L77 between Clayburn and Atchelitz, and
3. Atchelitz (230/69 kV) Substation near Yarrow in Chilliwack connected to circuits 2L77 between Clayburn and Atchelitz and 2L78 between Atchelitz and Rosedale.

The connection of the 230 kV system to one of the 500 kV lines involves constructing a 500 kV substation adjacent to either McLellan, Clayburn or Atchelitz Substations, constructing a 500 kV transmission loop (to connect one of the existing 500 kV lines to the new substation) and adding overhead groundwires on the 500 kV line which supplies the station for approximately 1.6 km either side of the new substation.

2.0 PROJECT DETAILS AND SCHEDULE

2.1 General

This section outlines the technical project details for both the substation and the transmission line loop. These details would apply to one or more of the alternatives. A proposed project schedule is also provided.

2.2 Substation Details

The initial station layout would accommodate two 500 kV line terminations and one bank of 500 - 230 kV transformation. A second transformer bank would be added, as required, in a later stage development.

a) Equipment

New equipment installed as part of the 500 kV substation would include:

- four 500 - 230 kV single phase transformers each rated 200 MVA and arranged as a three phase bank with one spare,
- three 500 kV circuit breakers,
- two 230 kV circuit breakers
- 500 and 230 kV disconnect switches, potential devices and surge arresters, as required.

Figure 3 shows an elevation of a 500kV switchyard arrangement proposed for Clayburn Substation which outlines the location of equipment and the relative height of equipment and structures within the switchyard.

b) Control Facilities

Station equipment would be controlled remotely from Burnaby Mountain Control Centre as well as locally from the station site. At least one new system of 500 kV protection would be required because the in-out transmission loop effectively creates a new line.

Depending upon the alternative site selected the existing control building would accommodate additional protection, control and communications equipment, otherwise an addition or new building would be required. Control buildings are usually one story in height.

c) Station Access

Generally, a two lane road access built to highway load bearing and grade standards is required. This would accommodate anticipated frequent heavy loads during the construction period. During the operating life of a station there would be occasional light vehicle traffic only, but provision to move heavy loads would have to be maintained in the event of equipment failure.

d) Station Size

A compact design utilizing outdoor equipment and structures is proposed for the application at Clayburn or Atchelitz and would require approximately 1.5 to 2 ha. An indoor or outdoor gas insulated switchgear design is being proposed for the application at McLellan because of the limited available site area.

Compared to a conventional 500 kV substation located in a rural area, the compact design proposed for Clayburn or Atchelitz reduces the area required for a substation by a factor of approximately 30 percent. The gas insulated design proposed for McLellan would reduce the site area required by a further 30 percent. The gas insulated design has not been proposed for Clayburn or Atchelitz because there is sufficient space at each site to accommodate the compact outdoor design and the additional one-third cost for the gas insulated design could not be justified.

e) Construction Methods

The typical construction crew expected during this activity at site would be approximately seven persons. Typical construction equipment required would be a bulldozer, backhoe, pile driver and trucks for civil construction and two cranes and trucks for electrical construction. Material and equipment delivery would be by flat deck and low bed trucks. Additional details are provided in Appendix C.

2.3 Transmission Details

Connection of a 500 kV substation to one of the 500 kV transmission lines on the 500/230 kV corridor will require a 3 phase single circuit 500 kV in and out loop. System studies have confirmed that the loop should be from Circuit 5L41 because of voltage stability and operating considerations.

Conductor specifications and ratings and tower clearances (air gap) for a loop from 5L41 shall match those of Circuit 5L41.

Circuit 5L41 is a 500 kV 3 phase single circuit AC transmission line connecting Kelly Lake Substation located approximately 10 km west of Clinton B.C. and Ingledow Substation in Surrey B.C.. This circuit was constructed in the mid 1960s as part of the Portage Mountain Development (Bennet Dam/ G.M. Shrum Generating Station). The length of the circuit between Kelly Lake and Ingledow is 320 km. Groundwire protection is currently provided for approximately 1.6 km from each station. Details of Circuit 5L41 are provided in Appendix B. Provided below is a summary of the design parameters.

a) Conductor

The conductor on each phase of 5L41 is 4 bundle. Each sub-conductor of the bundle has an aluminum cross sectional area of 316.1 mm² with a 48/7 stranding composed of 48 aluminum wires around 7 steel wires. Both ACSR (aluminum conductor, steel reinforced) and AACSR (aluminum alloy conductor, steel reinforced) grades are used at various locations along the circuits length. From Agassiz in the east Fraser Valley to Ingledow all conductor is ACSR. Where a 500 kV transmission line enters a substation, a 2 bundle conductor is utilized with an aluminum area of 1167 mm² with a stranding composed of 91 aluminum wires (ASC - aluminum stranded conductor). Clearances on Circuit 5L41 were upgraded in 1990 to allow operation at 2,500 amps which translates into a maximum conductor operating temperature of 65° C at 30° C summer ambient operating condition.

The 500 kV loop will use the 4 bundle 316 mm² ACSR conductor for full tension spans and 2 bundle 1167 mm² ASC conductor for dead-end tower jumpers, slack spans and drops into the station.

b) Structures

Figure 4 outlines various 500 kV lattice steel in the B.C. Hydro system and possible steel pole types which can be considered for a 500 kV loop.

The towers proposed for the loop would be similar to those on the existing circuit (5L41) and are a steel lattice type. There are sufficient steel lattice towers in existing uncommitted inventory of B.C. Hydro to construct this project.

An alternative to lattice steel towers is a steel pole design. The steel pole structures would comprise of a two pole H-frame pipe type structure for tangent to light angle cases and a three pole structure for heavy angle or dead-end type cases. B.C. Hydro has to date only constructed one short section of 500 kV steel pole structures.

The differences between lattice steel and pole type structures are the area occupied at the ground and perceived aesthetics and cost. The steel pole structures would occupy a smaller total area at the ground compared to a lattice steel type. For example, each pole of pipe type structure might vary in diameter at the ground from 2 to 3 metres while the base area of a lattice tower varies from 9 to 13 metres across the base. In elevation a steel pole structure could appear to be much more massive because it is solid steel. Steel pole structures have traditionally been more costly to fabricate and install than lattice steel structures.

Foundations for lattice steel structures can consist of steel mat type grillages buried in earth for good bearing soils, timber pile or steel caisson foundations in weak bearing soils and rock anchor bolt foundations are utilized in bedrock. Foundations for steel pole structures consist of either directly buried sections of the structure or the poles are set in steel caisson foundations. Based on past cost experience, the steel pole foundations are much more costly to install on the basis of a individual structure than lattice steel towers, especially in the weaker bearing soils.

c) Insulation and Clearances

Nominal insulation per phase (for an I-string configuration) consists

wide on suspension type towers or 21 units of 220 kN strength insulators each 156 mm high by 280 mm wide on dead-end type towers.

Tower clearances are required for a switching surge level of $2pu$ which requires a 3100 mm clearance from steel to conductor.

The ground clearances will meet or exceed those required by Canadian Standards Association (CSA) Standard CAN-C22.3 No.1 M87, Overhead Systems.

d) Overhead Groundwire and Counterpoise

The installation of overhead groundwires (OHGW) and buried counterpoise are protective measures for substation equipment and to allow collected lightning strokes to be dissipated into the ground, respectively.

Whenever a 500 kV transmission line is connected to a substation it is B.C. Hydro's practice to install approximately 1.6 km of overhead groundwire on the line extending from the substation. For the 500 kV loop of the Fraser Valley Reinforcement Project, a total of approximately 3.2 km (2 x 1.6 km) of 2-wire overhead groundwires will be required. Groundwire on 500 kV lines is a 9 mm diameter galvanized guy strand. Recent studies conclude that groundwires are most effective if they are installed beyond the two outer phases at a level of the lower cord of the tower bridge. The installation of groundwire for a 500 kV substation located along 5L41 will require the installation of the groundwire on new construction from a station site to Circuit 5L41 (less than 500m length) and then retrofit existing towers on 5L41 to support the groundwires (balance of 1.6 km). Figure 5 outlines the proposed geometry and methods to install groundwires on structures for the loop and the retrofit of existing structures.

Buried counterpoise wire, usually 10 mm diameter galvanized steel guy strand, is installed from steel towers within the area of the overhead groundwire protection to achieve a maximum 20 ohm footing resistance. Where possible, counterpoise wire is buried in a minimum 0.5 m deep excavated trench and is backfilled after installation with native material. Depending upon the results of resistivity measurements taken at each tower the counterpoise may consist of a single run of wire, for example

20 metres in length, or two continuous lengths of wire interconnecting adjacent towers.

e) Right-of-Way (ROW) and Clearing Requirements

B.C. Hydro determines the right-of-way for its 500 kV lines in accordance with CSA Standard CAN-C22.3 No.1 M87 Overhead Systems. Right-of-way width depends upon the conductor type, conductor sag, span length and tower geometry as well as future needs. For a 500 kV line located in the Fraser Valley, typical minimum dimensions for a right-of-way are outlined below:

Centre-line, circuit to circuit 500kV	-	41 metres
Centre-line, circuit to circuit 500 to 230 kV	-	38 metres
Centre-line to right-of-way edge	-	32 metres

Clearing for a 500 kV transmission line removes standing trees and brush which can pose a hazard to the operation of the line and the public. The width of clearing depends upon factors such as system security requirements, ground slope, tree height and rate of growth, wind firmness of trees, etc. For a 500 kV loop into a station in the Fraser Valley, system security requirements would be considered very high and therefore a very wide clearing width would be required to preclude any trees contacting the conductors. This may require clearing outside of the legal right-of-way affecting any tall trees which are identified to pose a hazard to the line, if trees exist at all along the loop.

f) Access and Construction Methods

Manpower and equipment used for a 500 kV transmission line loop are outlined in Appendix C.

Ground access will be required to all sites requiring foundation installation work, where conductor installation set-up points are selected and preferably to all sites where tower erection work including retrofitting of existing groundwire supports will occur.

Access must be sufficiently developed to allow for the largest equipment required for the work. Work sites must be large enough, to accommodate one to two cranes and provide room for assembly of steel for new towers or retrofitting existing towers. Two cranes will be required to retro-fit existing Type "A" towers to support the new groundwires, one to support the existing conductor when a crossarm is removed and the second to remove and replace the crossarm.

Short term outages will be required on one of the existing circuits to permit various activities to take place in a safe manner. Outages for the installation of a new tower, including conductor work associated with the tower type could require the following estimated time on an operating 500 kV line:

- daily outages for movement and operation of equipment like cranes and pile drivers, over a one to two week period,
- erection of towers, from two days to one week continuous per suspension or dead-end tower type, respectively,
- addition of groundwire to existing structures, two towers per day can be retrofitted.

2.4 Proposed Schedule

The proposed in-service date for the 500 kV substation and transmission loop in the south central Fraser Valley is 1 October 1994. Figure 6 outlines the proposed schedule for the project consisting of the project application phase, substation expansion and the transmission loop to meet the 1 October 1994 in-service date. The schedule and commencement of activities are contingent upon receiving regulatory approvals.

For the substation site preparation and civil construction would begin during the summer of 1993 and consists of clearing of the site, grading and filling and foundation work. Electrical installation consisting of structure and equipment erection would proceed during the summer of 1994 to meet an 1 October 1994 in-service date.

Connecting 5L41 to the new substation will require multi-day and daily outages

to new towers on the centre-line of the existing circuits and retrofit existing structures with groundwires.

Outages on a major 500 kV circuit such as 5L41 are not possible during the winter period, because of the high load, or in summer because of less reliability and current capacity due to the effects of lightning and warming. Considering the above, the best time to schedule outages would be in the May-June period.

Whenever possible, outage duration should be minimized for the following reasons:

- a preliminary cost estimate of additional transmission losses incurred because Circuit 5L41 is out of service is \$5,000 to \$6,000 per 12 hour day.
- outages on major circuits like 5L41 impact system security.

3.0 ALTERNATIVES

3.1 General

A study of alternatives for providing system reinforcement for the Fraser Valley concluded that the installation of a 500 kV substation and a 500 kV transmission loop to the new substation from one of the existing 500 kV transmission lines passing through the southern Fraser Valley provided the most secure long term solution.

Feasible substation sites for the Fraser Valley Reinforcement would ideally be adjacent to existing 500 kV transmission lines and to existing 230 kV substation facilities to facilitate interconnection. Three such sites in the Fraser Valley do exist, located as follows:

- McLellan Substation in Surrey B.C., on the west side of Langley B.C.,
- Clayburn Substation in Matsqui, just north of Abbotsford and
- Atchelitz Substation near Yarrow in Chilliwack.

The addition of a 500 kV substation and connection of the substation to the existing transmission corridor is considered technically feasible at all three alternative sites.

Detail design has not progressed for any of the alternatives, though feasibility studies in connection with site development for the 230 kV sites at McLellan and Clayburn included review and consideration of 500 kV requirements.

3.2 McLellan Substation

a) Existing Site Description

Figure 7 outlines the McLellan Substation site and existing features and shows the general area for the proposed 500 kV substation addition and transmission line loop location alternatives.

McLellan Substation is a 230/25 kV substation located on the west side of Langley B.C. in the District Municipality of Surrey. The site is about 0.5 km

east of Latimer Road between 54th Avenue on north, and the Nicomekl River to the south. The existing substation property is approximately 400 by 300 metres in plan with an additional 150 metre wide strip extending from the station site west to the 500/230 kV transmission corridor. The site is legally described as Lot 15, Plan 30494, NW 1/4 Section 3, TP8. The present 230 kV substation was developed in the early 1980s to meet the growing load in east Surrey and Langley and presently utilizes approximately one-third of the existing property. The old 69 kV substation located on the southeast corner of the property has been decommissioned.

A single 230 kV wood pole loop (Circuits 2L75 and 2L76) from the lattice steel 230 kV line between Ingledow and Rosedale enters the south face of the station. Four 69 kV circuits are located on the old B.C. Hydro railway right-of-way immediately to the south of the station. These 69 kV circuits are presently not connected to the station. Various distribution circuits emanate from the north face of the station along 54th Avenue. The 500/230 kV transmission corridor is located about 300 to 400 metres to the west of the site crossing or to the west of the Southern Railway (B.C. Hydro right-of-way) rail line to Roberts Bank.

The McLellan Substation site is level and generally surrounded by coniferous trees. Soils at the site have poor load bearing capability. When the existing 230 kV station was installed all equipment was installed on very deep steel H pile foundations. Structures on the 230 kV wood pole loop are attached to timber pile foundations and 500 and 230 kV structures on the adjacent corridor are also supported on pile foundations. Immediately to the west of the existing 230 kV station is a large drainage ditch right-of-way which flows into the Nicomekl River.

b) Proposed Substation Expansion for 500 kV

Figure 8 outlines in greater detail the location of existing plant within McLellan and the location for a proposed 500 kV addition. The plan was prepared in 1981 as part of a study for the station. B.C Hydro owns the property adjacent to the existing 230 - 25 kV substation, on which the proposed 500 kV switchgear building and 500 - 230 kV transformation would be located. 500 kV gas insulated switchgear would be utilized because of the space limitations dictated by the size of the site between the 230 kV substation area and the drainage ditch right-of-way to the west. Switchgear would be located indoors in a building situated on the east side of the north-south drainage right-of-way. There would be insufficient room on the east side of the drainage right-of-way to locate the

500 kV terminal structures so it would be necessary to develop an area to the immediate west of the drainage right-of-way to locate the two structures. A new control building similar to the existing building would be required. McLellan has existing microwave control facilities.

c) Proposed 500 kV Transmission Loop

Two possible alternatives for location of a 500 kV loop to the proposed location of the two 500 kV terminal structures located on the west side of the drainage right-of-way are shown on Figure 7 as alternatives "A" and "B".

Both alternatives would require the installation of dead-end towers into 5L41. The northerly alternative "A" would require two dead-end towers located either side of 5L41 structure 566/2, two dead-end towers located a short distance to the east, on the north side of 5L81 and two intermediate towers on the east side of the Southern Railway tracks. Up to 75 metres of additional right-of-way would be required for the northerly leg of the loop. The southerly alternative "B" would provide a more direct route requiring one less dead-end tower and no additional right-of-way but would cross the existing 69 kV and 230 kV circuits.

The length of each 500 kV transmission loop would be less than 400 metres. Overhead groundwire would likely be extended 1 km northwest on 5L41 to the north side of the Highway 10 near Siddons Road and 1 km southeast to a structure near 56th Street in Langley. Approximately 8 existing towers would be retrofitted to support the groundwires.

For either location alternative, timber pile or steel caisson foundation will be required to support all towers of the loop. Depending upon the time of year when construction occurred the weak bearing soil conditions could also impact tower erection and conductor installation activities. Installation of new crossarm extension on existing towers to the east of a loop point through the Nicomekl River floodplain could be seriously constrained by restrictions to mitigate impact during construction on fisheries and waterfowl habitat. Helicopter installation may be a feasible but expensive alternative for some of the installation work.

d) Schedule Constraints

There are four factors that could impact the schedule:

1. Fisheries, wildlife and water quality concerns in the Nicomekl River and floodplain area. Construction work maybe limited to the 1 July to 15 September period.
2. Required outages on 5L41 for construction purposes.
3. Additional engineering design work is required at McLellan whereas this work has essentially been completed at Clayburn Substation.
4. Acquisition of additional right-of-way if alternative "A" is chosen for the 500 kV loop into the substation.

3.3 Clayburn Substation

a) Existing Site Description

Figure 9 outlines the area surrounding the Clayburn Substation site and shows existing features and the area for the proposed 500 kV substation addition and transmission line loop location.

Clayburn Substation is a 230/25 kV Substation located about 0.5 km west of Highway No. 11 off Valley Road in the District Municipality of Matsqui. The present station was developed in the early 1980s to meet the growing load in Abbotsford, Matsqui and Aldergrove. The legal description of the Clayburn site is Lots 10 - 15, Plan 2173 and Lot 64, Plan 66729, New Westminster District. It was acquired in 1979. The site is zoned Agriculture 3 and is designated Agricultural in the official Community Plan. The property is approximately 12 ha. in area and is large enough to accommodate present, planned and ultimate station requirements.

Site access is from Highway 11 and Valley Road. Both the Southern Rail and Canadian Pacific Railway tracks are in close proximity to the site.

The Clayburn Substation site is located on top of a small terrace which was previously used as a gravel pit. The site slopes uphill to the north and downhill to the flats of the Willband Creek drainage. Soils at the site consist of silt, clay, sand and gravel and only a limited amount of the material is suitable as fill. The mixtures of these materials are randomly located.

A 230 kV wood pole loop (Circuits 2L76 and 2L77) from the lattice steel 230 kV transmission line between Ingledow Substation and Rosedale Substation enters from the south. Various distribution circuits emanate from the north-east face of the station and head east towards Highway 11 and west towards Gladwin Drive. The 500/230 kV transmission corridor is located 500 metres to the south of the existing substation.

The existing right-of-way for the loop, acquired from the Districts of Matsqui and Abbotsford in 1984, is approximately 330 metres in width, and is wide enough for the two proposed 500 kV single circuit lines and the two existing 230 kV wood pole lines.

The existing 230 kV loop crosses the Willband Creek flood plain over an area immediately east of a previously used sewage lagoon. In the mid 1980s use of the sewage lagoon was discontinued and the area (including the area beneath the 230 kV lines) was converted to a landfill for special waste not accepted by other landfill (e.g. animal carcasses, gypsum board, etc). This use continues to the present time.

The old sewage lagoon and existing landfill site is surrounded by a leachate control system (see Appendix D for plan). Matsqui municipal staff recommended that excavations stay at least 10 metres from the 8 and 10 inch diameter pipes of the system. There is an above ground sewer line adjacent to the north boundary of the 500/230 kV transmission corridor. The Willband Creek floodplain is designated a Development Permit Area. Requirements for work and installations within the special use area are outlined in Appendix F.

Structures on the 230 kV wood pole loop are attached to timber pile foundations and the 500 and 230 kV structures on the adjacent corridor are also supported on pile foundations.

b) Proposed Substation Expansion for 500 kV

B.C. Hydro owns the property adjacent to the existing 230/25 kV substation, on which the proposed 500 kV switchyard and 500/230 kV transformation would be located.

The station addition at Clayburn would be an outdoor compact design to minimize site development costs because of the topography and site conditions which limit the available area for a conventional sized substation. Though the site area is

restricted it is not limited in area to the point where an gas insulated design can be justified. Due to topographical constraints, the four single phase transformers will be located on the east side of the station access road and a bus or aerial span approximately 30 metres in length will be required for connection of the 500 kV switch gear and the transformers. Reduced tension terminal structures will be used for the 500 kV line terminations.

Since initial design studies were completed for a future 500 kV station when the property was acquired, up to 9 metres of soil were removed from the proposed 500 kV switchyard site. This could add to site development costs as more native material will have to be removed and replaced with suitable import material. Subject to geotechnical studies, major items of equipment will likely be supported on pile foundations due to the inconsistent nature of the native soils.

c) Proposed 500 kV Transmission Loop

The location of a 500 kV loop into a proposed 500 kV substation at Clayburn is dictated by the following considerations:

- The loop must be located west of 5L41 structure 545/1 because the construction of a new tower east of structure 545/1 would require and outage on the 230 kV loop into Clayburn, thus taking Clayburn out of service and would impact the C.P. Rail crossing further to the east.
- Is not desirable to locate new towers within the confines of the old dike system for several reasons. Firstly because of the unknown and inconsistent nature of the soils and landfill material; secondly, material in the landfill could pose a hazard to construction crews involved in excavation; and lastly the landfill site may at sometime in the future be utilized for recreational purposes. If towers were located within old landfill area they could diminish the potential for future use of the landfill site.

The proposed routing from the corridor to the station crosses the old sewage lagoon and capped portion of the landfill, and is within the existing right-of-way. The new substation would be approximately 45° to the loop, thus requiring a heavy angle turn to enter the station. A total of seven new 500 kV structures would be required as follows:

- two dead-end type structures would be located on the centre-line of Circuit 5L41 to the west of existing structure 545/1,
- two suspension type structures would be located on the north edge of the transmission corridor right-of-way,
- two dead-end structures would be located on the north edge of the landfill just south of the station, and
- one suspension type structure would be located on the centre-line of Circuit 5L81 between the 5L41 loop to raise the conductors of 5L81 to allow the loop to cross beneath.

The length of each portion of the loop is approximately 0.45 km.

It is estimated that the seven new towers would all be constructed on timber pile or steel caisson type foundations. Caisson foundations may have the advantage of reducing outage time when installing foundations beneath existing lines because the caisson can be installed in sections, thus limiting the needed equipment height.

The two overhead groundwires would be installed for approximately 1.2 km east and west on 5L41 from where the loop connects to the existing line. The groundwire would be added on 5L41 from one structure east of Highway 11 to the second structure west of Gladwin Road. Approximately 10 existing structures would be retrofitted to support the groundwires.

d) Right-of-Way Clearing

Clearing of any significance is not expected to be required. The only exception maybe a few alders and shrubs which will be felled by hand methods.

e) Access Road Construction

Soil and drainage conditions within the Willband Creek floodplain will require the importation of sand fill, and culverts will be installed for proper drainage. The sand could be laid on fibre mats to minimize the spread and improve bearing capacity and could be removed upon completion of construction. Outside of the floodplain, existing access roads on the right-of-way and other municipal or private roads will be used to access work sites. The network of roads, railways, services and wetlands will require several moves to reach sections of the new

construction and the sites of existing towers to add the groundwires.

f) Schedule Constraints

There are two factors that could impact the schedule:

1. Fisheries, wildlife and water quality concerns in the Willband Creek floodplain encompassed by the special permit area; construction work maybe limited to the 1 July to 15 September period, primarily impacting construction of the 500 kV loop, but subject to detail study, civil construction on the station site may also be impacted.
2. Required outages on 5L41 for construction purposes.

3.4 Atchelitz Substation

a) Existing Site Description

Figure 10 shows the existing Atchelitz Substation site and the area for a possible 500 kV substation.

The existing Atchelitz Substation is located about 4 km north-east of Yarrow B.C. in the District of Chilliwack. It is on the west side of Lickman Road, 3 kilometres south of Highway 1. The existing substation was originally constructed as a 69 kV substation and was expanded to a 230/69/25 kV substation in the early 1970s. The site is located between the Southern Rail tracks and B.C. Hydro's major Fraser Valley transmission corridor. The area around the substation is used for agricultural purposes and is within the Agricultural Land Reserve. Hobby farms and light industrial and industrial agricultural parcels are interspersed throughout the area.

The site is legally described as Lot 4 NE 1/4 Section 10, TP.23 NWD, Plan 37692. The area of the existing substation site exclusive of adjacent rights-of-way is about 5 ha.

On the Sumas Prairie, soils have poor load bearing capability and all existing substation equipment and buildings are supported on pile foundations. The station site is not raised above the general surrounding area for flood protection. The site has been flooded on past occasions. The existing control building contains

office and workshop facilities and is used as a local headquarters for maintenance crews and District staff. Microwave facilities exist. Towers on the adjacent transmission corridor are supported on timber pile foundations.

Access to the site is via local roads from Highway 1 or alternatively from the adjacent railway.

b) Proposed Substation Expansion for 500 kV

The area of the proposed property expansion is approximately 170 by 335 metres square. B.C. Hydro does not own the adjacent property to the north on which the proposed 500 kV switchyard and 500/230 kV transformation would be located. Most of the required area is presently encumbered with the 500/230 kV corridor right-of-way and structures.

The station additions at Atchelitz would be an outdoor compact design to minimize site development costs and to utilize the vacant area between the existing 230 kV substation and Circuit 5L41. The site does not justify the additional thirty percent in cost for a indoor gas insulated design as proposed for McLellan Substation. The existing control building would be expanded or if it was inadequate an additional control building would be constructed. Existing microwave facilities are adequate.

All station equipment would be supported on pile foundations. Overall site development (civil construction) would be somewhat easier than the sites at McLellan and Clayburn alternatives.

c) Proposed 500 kV Transmission Loop

If a 500 kV substation is located adjacent to and beneath the existing transmission corridor the connection to 5L41 will be relatively simple. The provision of overhead groundwires on existing structures of circuit 5L41 will be increased, relative to the McLellan and Clayburn alternatives because there is no additional transmission construction between 5L41 and the proposed substation. Figure 10 shows the location of existing transmission and changes which could occur to accommodate a 500 kV substation and connection to 5L41.

Connection of 5L41 will require the conductors on 5L41 to be sectionalized. To accomplish this one of two methods could be employed. The first would be to install semi-strain insulator assemblies without jumpers on structure 530/4, a Type

"2D1" medium angle suspension structure. One new suspension structure would be constructed either side of the new 500 kV switchyard to provide adequate clearances over the switchyard. Drops to the substation bus would occur from the 4 bundle conductors either side of structure 530/4. The second alternative is to replace the Type "2D1" with a dead-end tower type. Additional suspension towers located either side of the new 500 kV switchyard may be required depending upon the height of the dead-end tower located within the new switchyard. All new towers would likely be constructed on pile/caisson foundations.

The two overhead groundwires would be installed for the required 1.6 km east and west on 5L41 from structure 530/4 where the station would connect. The groundwire will be added on 5L41 from a structure located between Tyson and Unsworth Roads to a structure located just east of Hopedale Road. Approximately 10 existing towers would be retrofitted to support the groundwires.

The existing right-of-way width and clearing are adequate.

Access for retrofitting the existing towers to install the groundwire will be on local roads and through private property to each site.

d) Schedule Constraints

There are three factors that will impact the schedule:

1. Required outages on 5L41 for construction purposes.
2. Additional engineering design work is required at Atchelitz whereas this work has essentially been completed at the Clayburn Substation.
3. Acquisition of additional property for the substation.

4.0 TECHNICAL COMPARISON OF ALTERNATIVES

4.1 General

The technical evaluation of the substation location and transmission route alternatives comprises analysis of such features as design, construction, security and maintenance. Some of this analysis is reflected in the estimated costs of construction for each alternative.

The substation and transmission loop components of the project were evaluated separately. Their evaluation is discussed in the following sections.

Appendix E outlines the evaluation and criteria for each component of the evaluation on more detail. Tables referred to in the following synopsis are also contained in Appendix E.

4.2 Substation Site Evaluation

The methodology for evaluating and comparing substation sites for the Fraser Valley Reinforcement encompasses analysis of design and construction factors which include station size, staging of installations, site topography, soils including ground resistance, access and special considerations. These evaluation components are described in more detail in Appendix E.1 and the results of the individual evaluations for the components for each station site are outlined on Table E.1.1.

4.3 Transmission Evaluation

The criteria used for the design/ construction and security evaluation of a transmission route are outlined in Appendix E.2. Rating of evaluation components is shown on the Transmission Technical Evaluation Criteria Table (Table E.2A) and the Security Evaluation Criteria Table (Table E.2C). The design and construction and security evaluation criteria used in the evaluation of the substation loop alternatives were developed for cross country transmission routes. Though the loops considered in this evaluation are very short in comparison to a cross country transmission line, the evaluations still provide a relative comparison.

The evaluations were based on a single circuit lattice steel tower configuration. The utilization of alternative steel pole "aesthetic" structures would result in a consistent relative increase in the rating factors for evaluation items such as design - deflections and special considerations, mainly because of foundation design. An additional factor relating to a steel pole alternative is the design effort which would be required to bring such an alternative to fruition. A lattice design is relatively simple in comparison because existing structural designs can be used.

a) Design/ Construction Evaluation

The technical evaluation is a compilation of the factors that reflect the cost of designing and constructing a 500 kV single circuit transmission line. After study of the alternatives at each station a rating for each of the components, with reference to the evaluation table, was given.

The evaluation components encompass design, clearing, access and special considerations. Each of the four evaluation components has five ratings ranging from low (I) to extreme (V). The results of the evaluation are provided on Table E.2B.

b) Security Evaluation

Table E.2C outlines the six major hazards considered in evaluating the security of the transmission line route segments. Each hazard has five ratings ranging from zero - very low (I) to extreme (V) depending upon the criteria described in the table. Each of the route alternatives has been evaluated for all of these security hazards on an overview basis. Table E.2D is a tabulation of the route alternative hazard ratings. The assessment of the security of the route alternatives was made with reference to this table. The security hazard rating for any route alternative cannot be arithmetically derived from the ratings. This is due to the varying relative significance and unrelated nature of the six listed hazards. The assessment of the security of the route alternatives was based on engineering judgement and experience with transmission line construction and maintenance.

4.4 Maintenance and Operations

The criteria for evaluation of alternatives from a maintenance and a operations perspective encompasses security and maintenance of the substation equipment, substation property, transmission line and right-of-way. Security refers to reliability of service which is measured by the percentage of the time the substation and transmission line are available for service. Factors which affect security are outages on the transmission line or within the station. Outages can result from non site location or non route dependent factors (e.g. equipment failures, etc.) and from site location or route dependent factors (e.g. adverse weather conditions, flooding, a tree falling on the line, slides or similar occurrences). For a transmission line its length is a factor because a longer line results in more exposure. Accessibility of the substation site or transmission line for speedy repairs affects the reliability.

For a substation, maintenance deals with the day to day maintenance activities such as periodic inspections, planned equipment adjustments, equipment overhauls and the control of surrounding vegetation. For example, planned regular maintenance activities in a substation include overhauling the breakers every eight years, overhauling the transformers every five years and protection control checks every three years. On a transmission line it includes the control of vegetation on the right-of-way and the maintenance of the access roads. There are also non-scheduled repairs which include repairing breakers, replacing damaged insulators, etc..

Substation maintenance activities are not really impacted by site selection unless the site requires special design features such as compact designs, non standard equipment, etc. For a transmission line, maintenance activities would be increased in some way due to factors such as line length and multiplicity of separate rights-of-way, as is ruggedness of the terrain, and the number of deflections all of which add to the maintenance activities.

Outages required to connect the transmission loop during construction are of particular concern from the operational point of view because of increased transmission losses and reduced system security with a major transmission line out of service. The Atchelitz site requires less outage time on Circuit 5L41 during the period of construction.

4.5 Summary of Technical Analysis

The most suitable alternatives, on the basis of individual evaluation components for the substation, transmission loop and maintenance and operations are summarized below.

<u>Evaluation Component</u>	<u>Most Satisfactory</u>
<u>Substation</u>	
Size	Atchelitz
Staging	No preference
Topography	Atchelitz
Soils	No preference
Access	Clayburn or Atchelitz
Special Considerations	Atchelitz

Transmission Loop

Design/ Construction	Atchelitz
Security	McLellan

Substation and Transmission Loop

Maintenance and Operations	Clayburn
----------------------------	----------

The substation evaluation favours an expansion at Atchelitz Substation mainly because of the less restrictive site conditions and topography affecting development of the sites with Clayburn a close second. McLellan is a distant third.

The transmission loop design/ construction evaluation favours Atchelitz because of the relatively simple connection of 5L41 provided by the close proximity of the proposed substation site to the transmission corridor. The security evaluation component is really not an issue, but does favour McLellan because of the expected less severe weather conditions as one moves west.

Maintenance and Operations personnel favour Clayburn over the long term.

5.0 COST ESTIMATES

The cost estimates for the addition of a 500 kV substation, a 500 kV transmission loop from 5L41 including the addition of groundwire and other project costs for completion in 1994, are shown on the table below. The present value of any future costs and the cost of losses are not included.

Fraser Valley Reinforcement Project - Comparative Cost Estimates
Cost Estimates in \$000s

Cost Component	McLellan Substation		Clayburn Substation	Atchelitz Substation
	Alt. "A"	Alt. "B"		
Substation	25,000		18,736	18,800
Transmission	2,427	2,077	2,398	1,186
Project Study and Application	818	818	818	818
Total Direct (Uninflated)	28,245	27,895	21,952	20,804
Inflation	4,168	4,116	3,223	3,012
Corporate Overhead	2,935	2,899	2,283	2,160
Interest During Construction	3,825	3,778	3,028	2,966
Total Estimated Cost	39,173	38,688	30,486	28,942

Notes:

1. Direct uninflated cost estimates are in 1990 dollars.
2. Direct substation costs include equipment procurement, labour, engineering and inspection and where required property acquisition.
3. Direct transmission costs include materials, labour, engineering and inspection for a 500 kV loop and installation of groundwire on the existing 5L41 and project management, property services and environmental inspection and services for the overall project subsequent to project licensing.
4. Project study and application costs are for environmental studies, technical studies, public consultation and regulatory application.

6.0 CONCLUSIONS OF TECHNICAL ANALYSIS

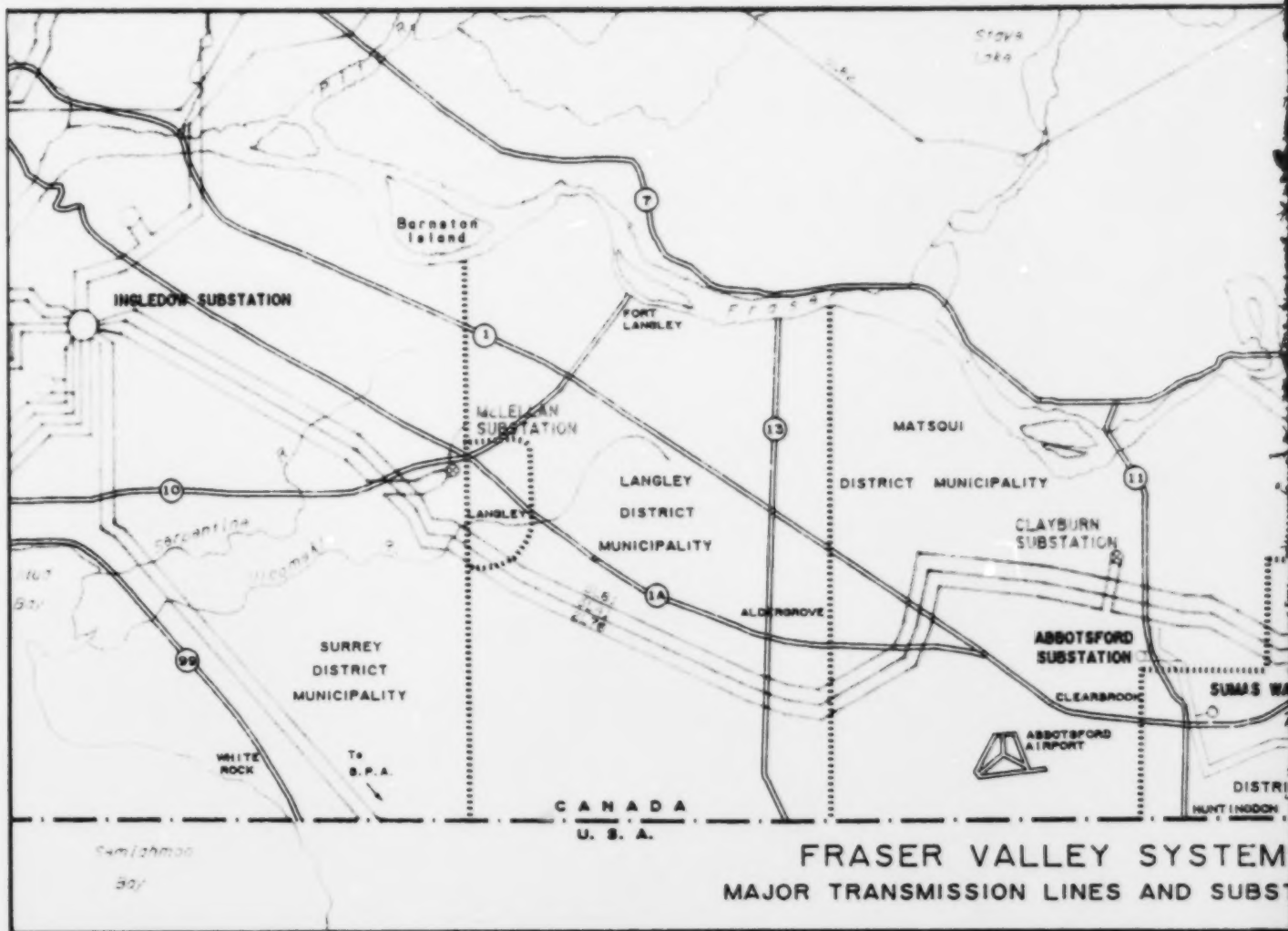
Three alternatives for transmission reinforcement for the south central Fraser Valley have been evaluated. The conclusion on technical parameters (which covers design, construction, and installed cost) slightly favours the Atchelitz site near Yarrow, in Chilliwack, followed by an expansion of Clayburn in Matsqui and lastly expansion of McLellan in east Surrey.

Operations and Maintenance favour the Clayburn site mainly because of the central location of Clayburn with respect to the Fraser Valley transmission system.

Overall, the technical evaluation favours the Atchelitz for providing system reinforcement Fraser Valley.

FRASER VALLEY SYSTEM REINFORCEMENT PROJECT

FIGURES



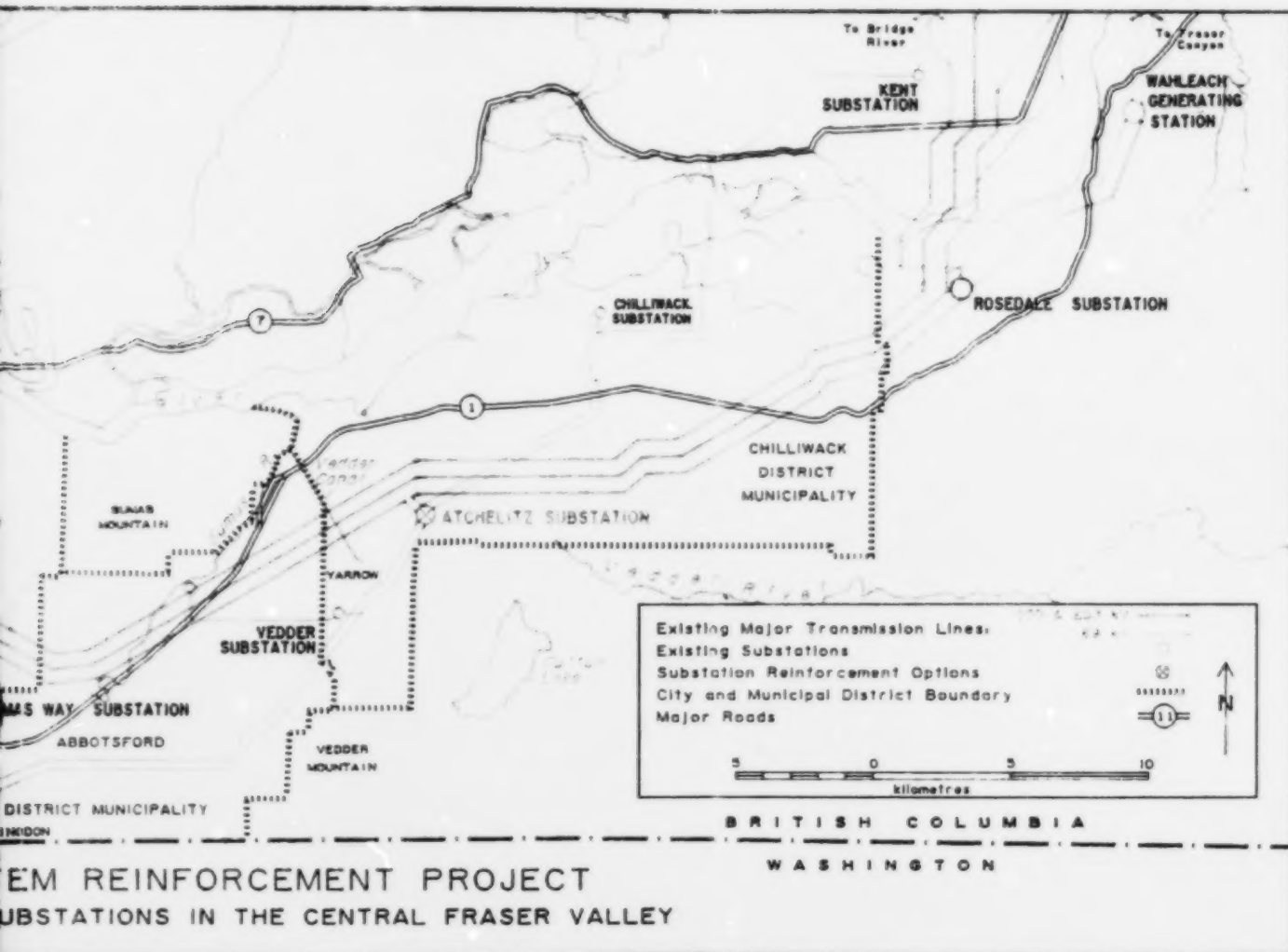
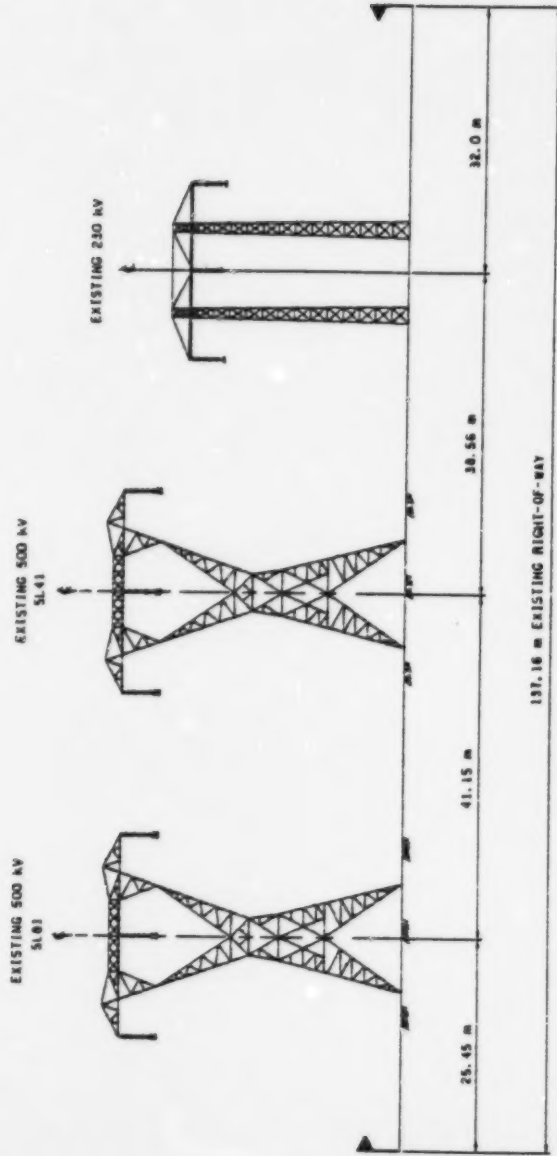


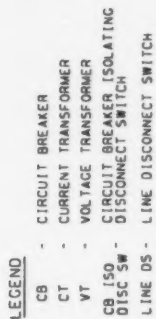
FIGURE 1



VIEW LOOKING EAST ALONG EXISTING
500/230 kV T/L CORRIDOR
INGLEDOW - ROSEDALE

EXISTING 500/230kV
TRANSMISSION LINE CORRIDOR

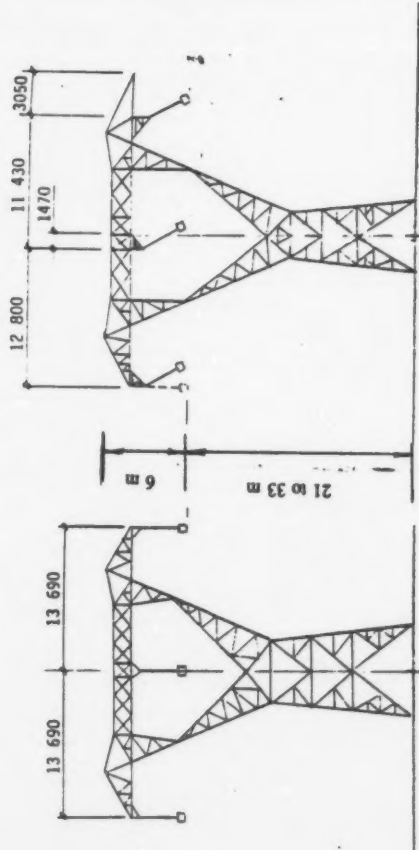
FIGURE 2

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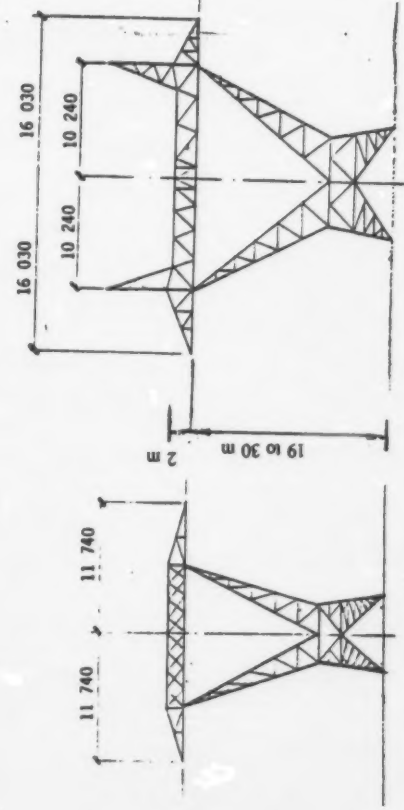
NOTE: ALL DIMENSIONS ARE IN METRES

[illegible]



TYPE 'D' MEDIUM ANGLE
SELF-SUPPORTING TOWER

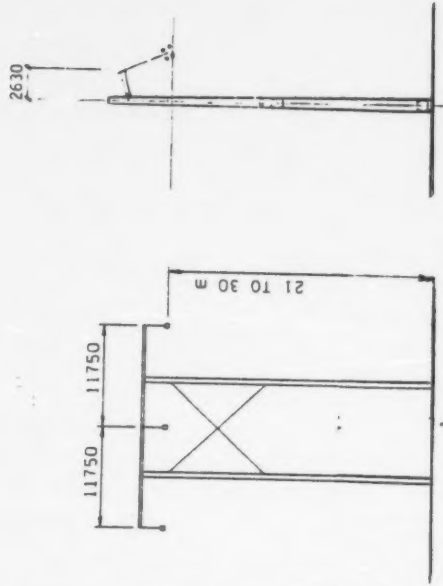
TYPE 'A' STANDARD
SELF-SUPPORTING TOWER



TYPE 'K' HEAVY ANGLE
DEAD-END TOWER

TYPE 'J' STANDARD
DEAD-END TOWER

LATTICE STEEL TYPES



POSSIBLE H-FRAME TYPE

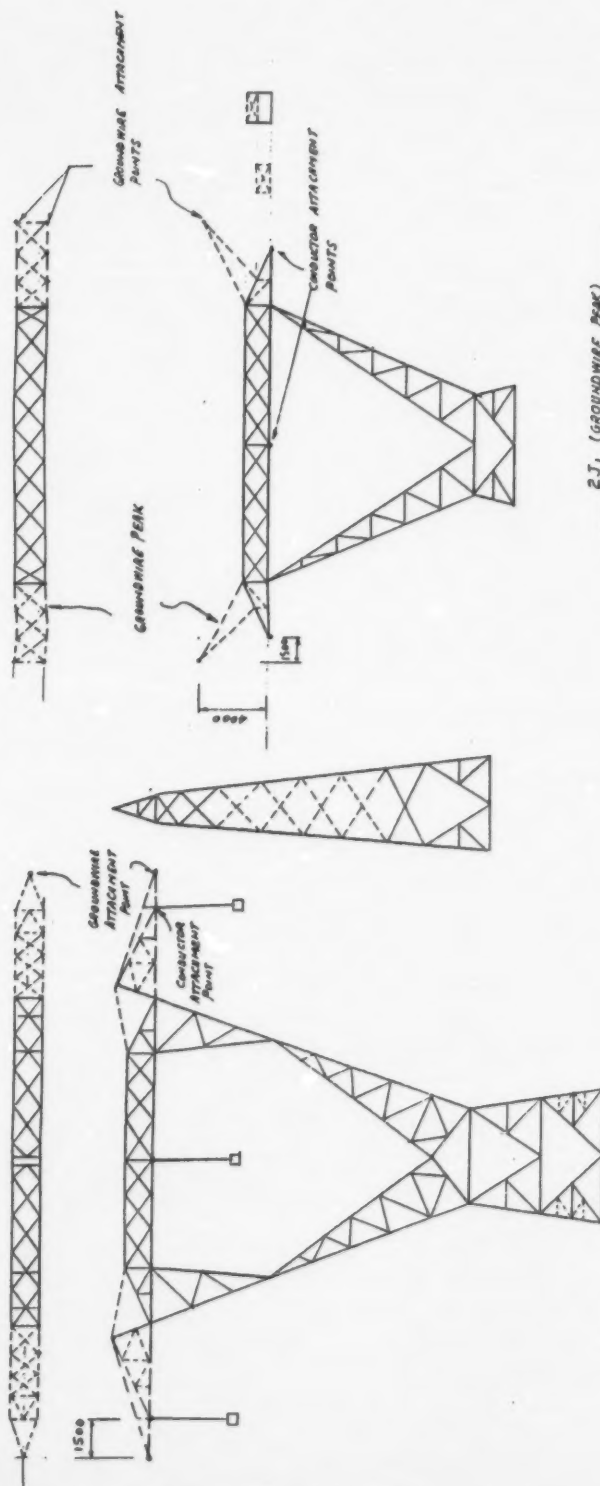
SINGLE POLE/PHASE (3 PER STRUCTURE)
FOR ANGLES AND AS DEAD-ENDS

STEEL POLE TYPES

Note: All dimensions are in millimetres
unless otherwise noted.

Fraser Valley System Reinforcement Project
Outlines of Various 500kV Tower Types
Lattice Steel and Possible Steel Pole Types

FIGURE 4

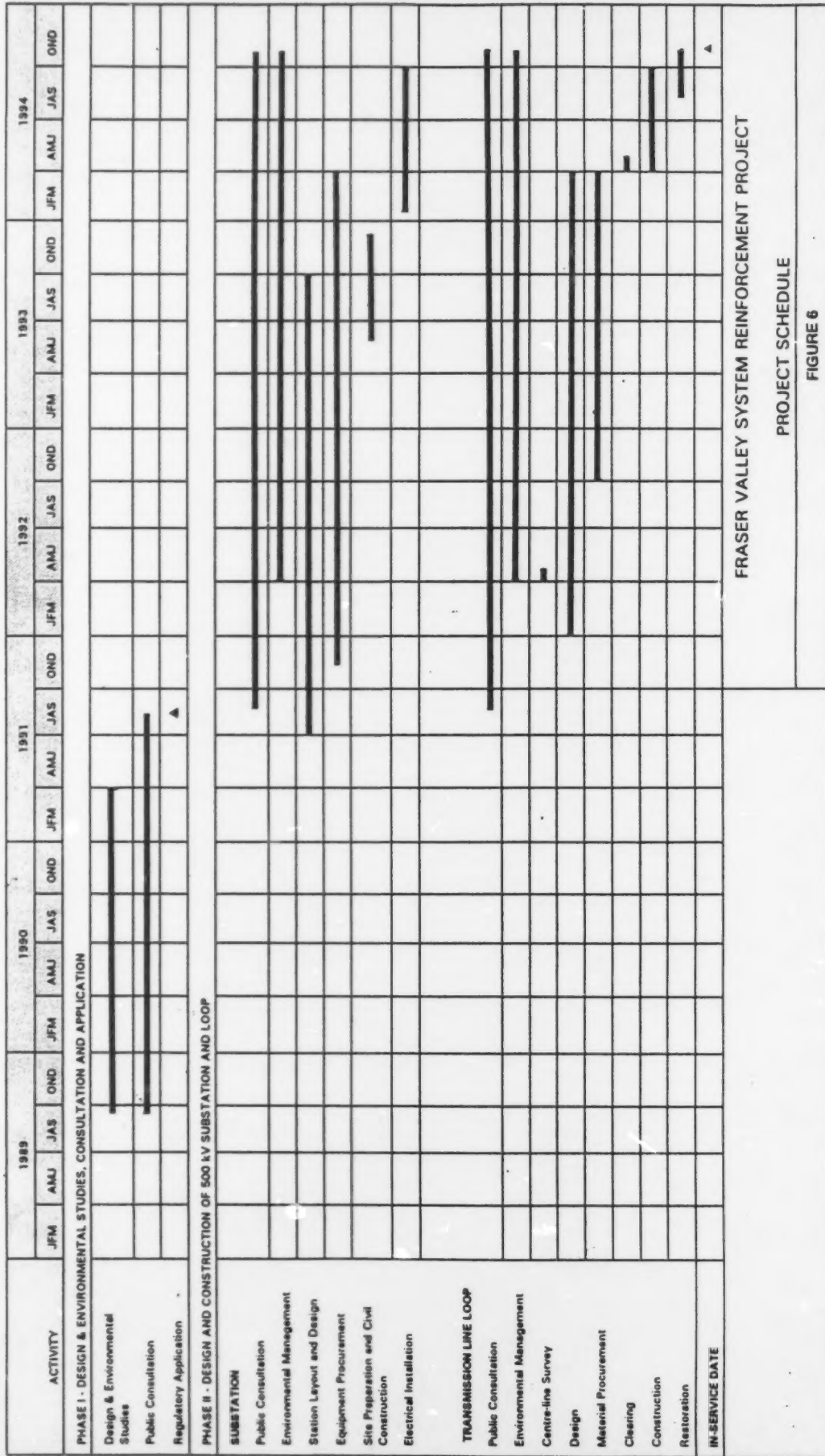


2J, (GROUNDWIRE PEAK)
(EST. STEEL WEIGHT PER TOWER = 800 KG)

2A (GROUNDWIRE ARM)
(EST. STEEL WEIGHT PER TOWER = 1000 KG)

FRASER VALLEY SYSTEM REINFORCEMENT PROJECT
PROPOSED GROUNDWIRE SUPPORTS ON
TYPE "2A" AND "2J" TOWERS

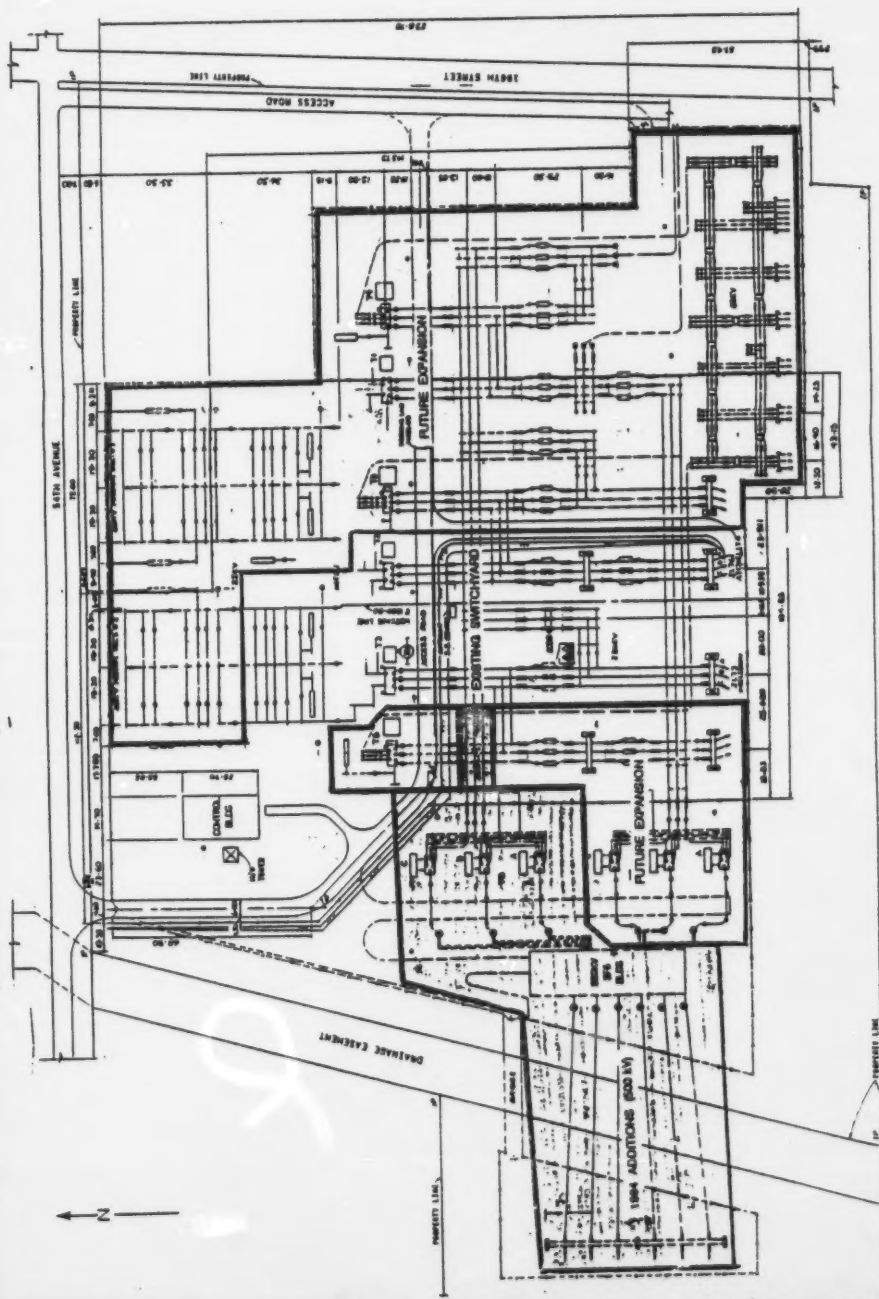
FIGURE 5



FRASER VALLEY SYSTEM REINFORCEMENT PROJECT

PROJECT SCHEDULE

FIGURE 6

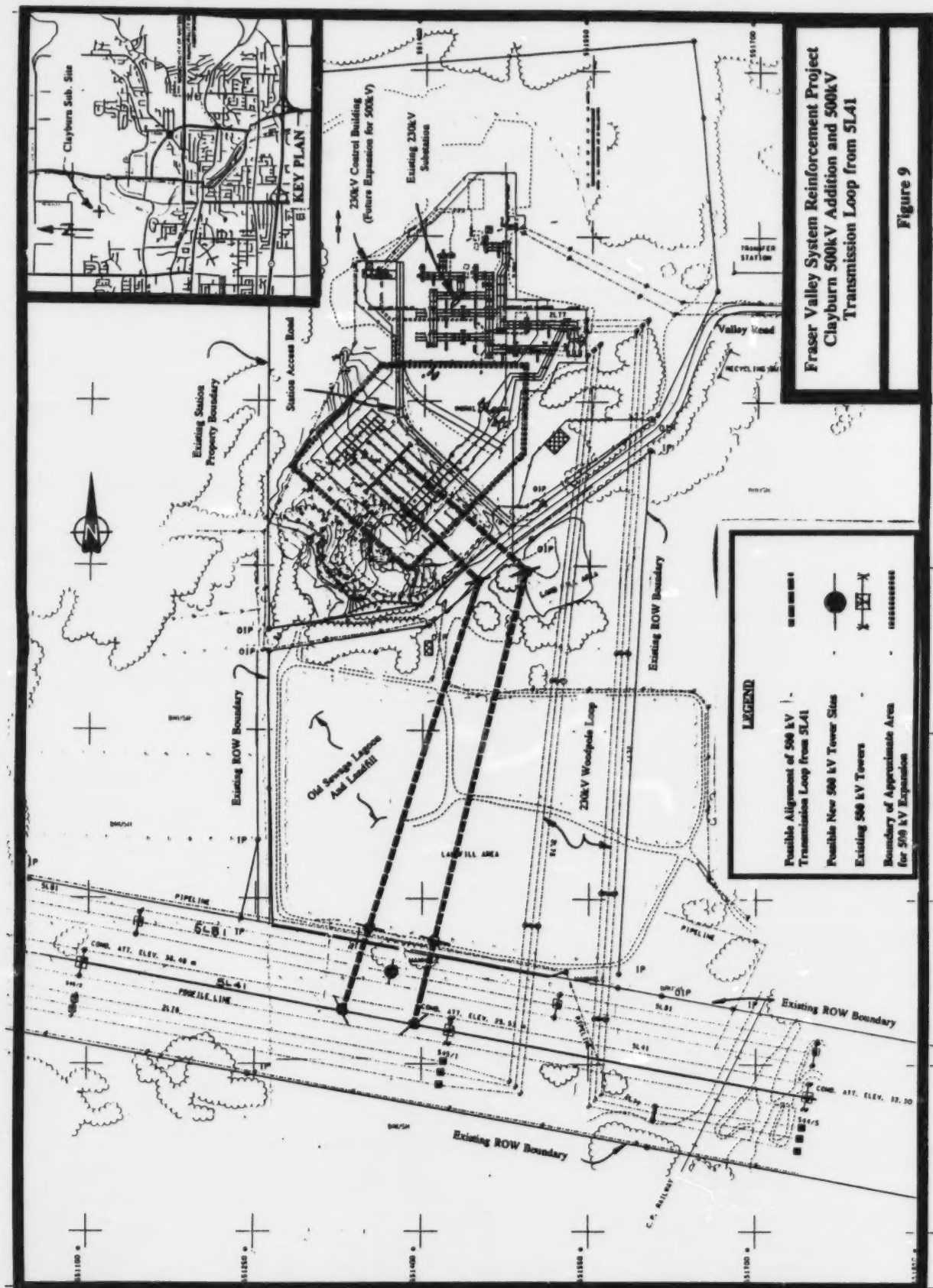


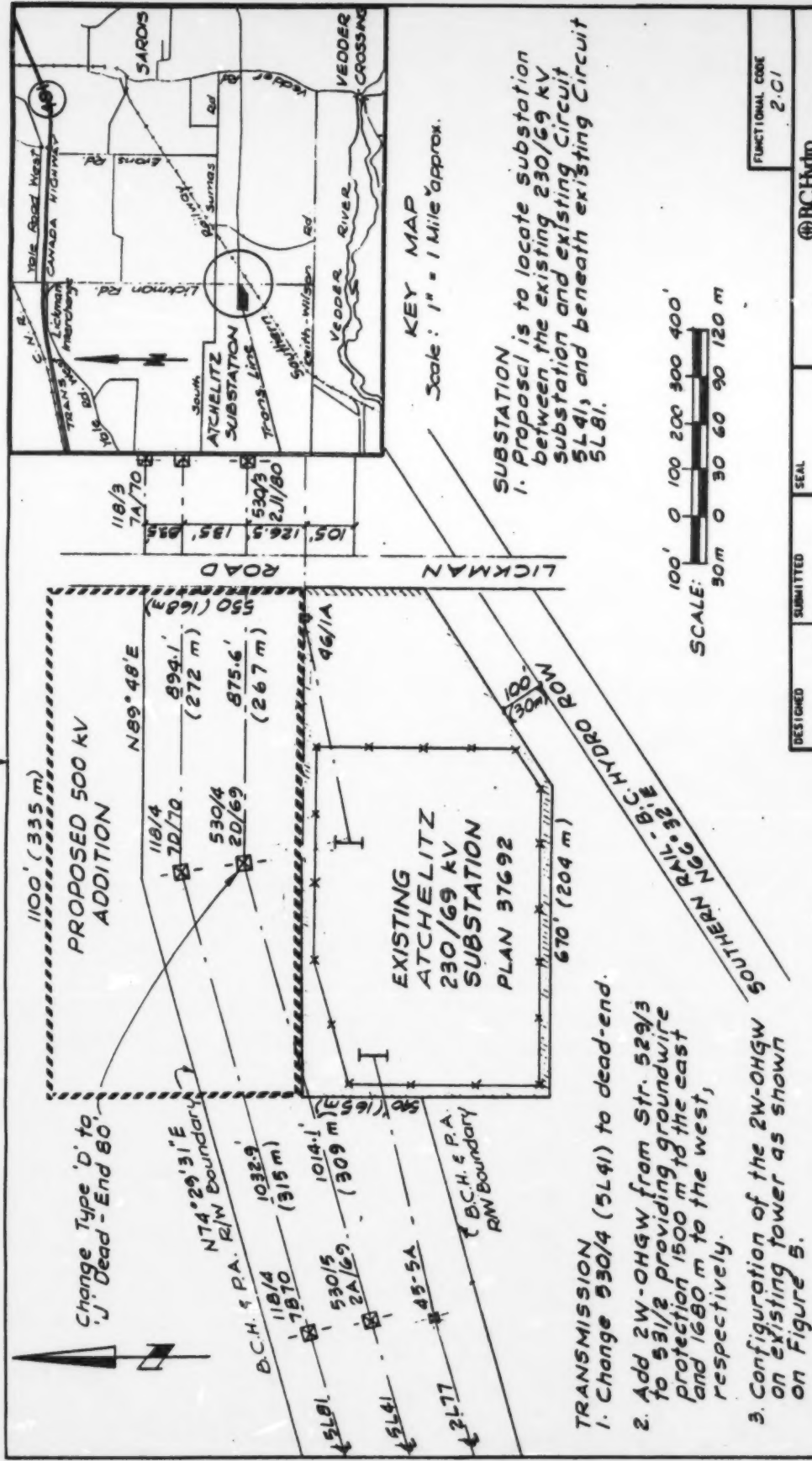
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Fraser Valley System Reinforcement Project

McLellan 500 kV Addition

FIGURE 8





FUNCTIONAL CODE
2.C1

DESIGNED		SUBMITTED		SEAL		 TRANSMISSION ENGINEERING DIVISION FRASER VALLEY REINFORCEMENT PROJECT ATCHELITZ 500 KV ADDITION # 500 KV LOOP FROM 5L41
DRAWN BG		INSPECTED				
CHECKED DRAFTING		INSPECTED				
CHECKED DESIGN		INSPECTED				
APPROVED		DATE		SCALE AS noted		
				Dwg. No.		FIG 10

FRASER VALLEY SYSTEM REINFORCEMENT PROJECT

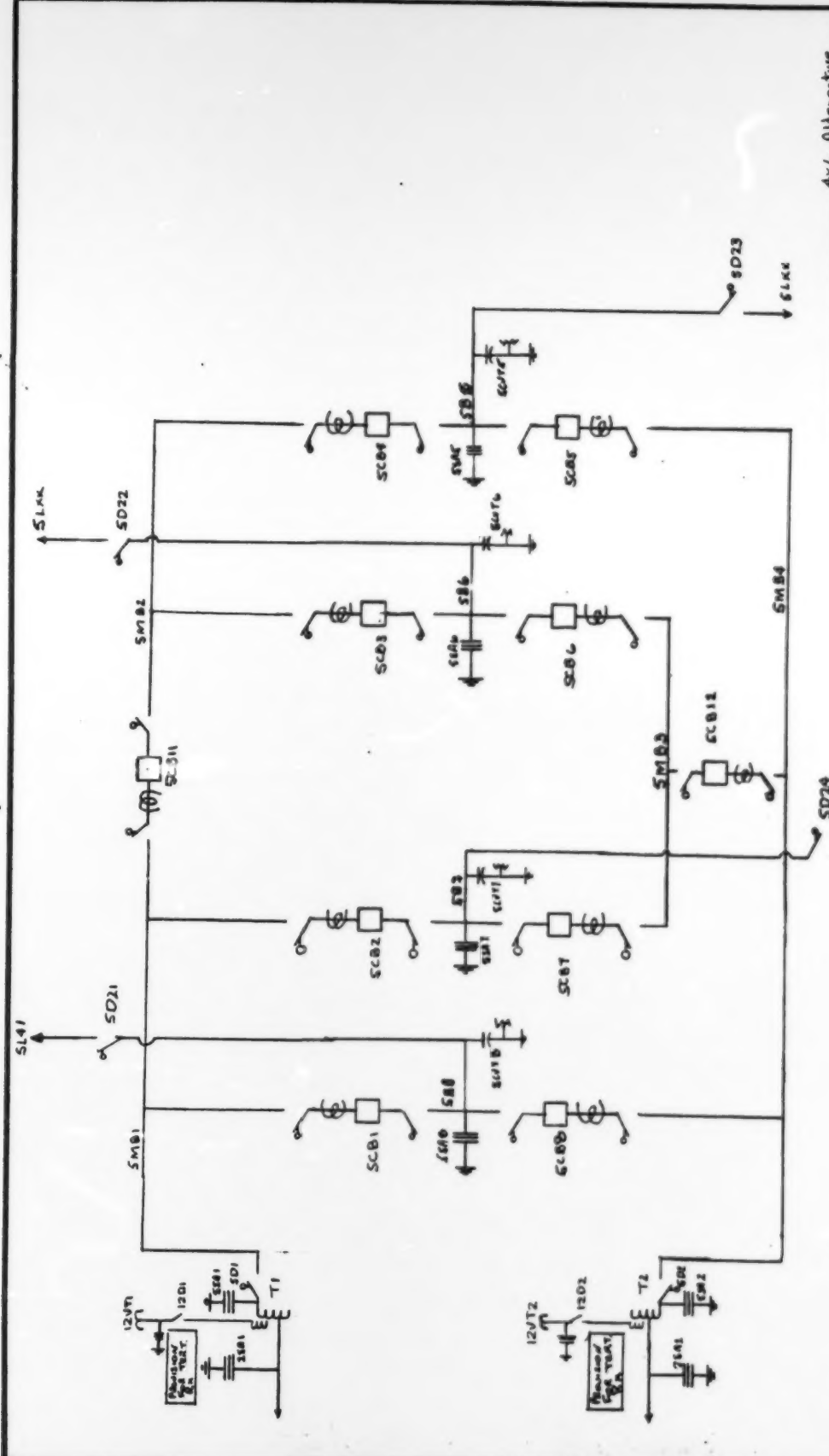
APPENDICES

APPENDIX A

SUBSTATION ONE LINE DIAGRAMS

Contents

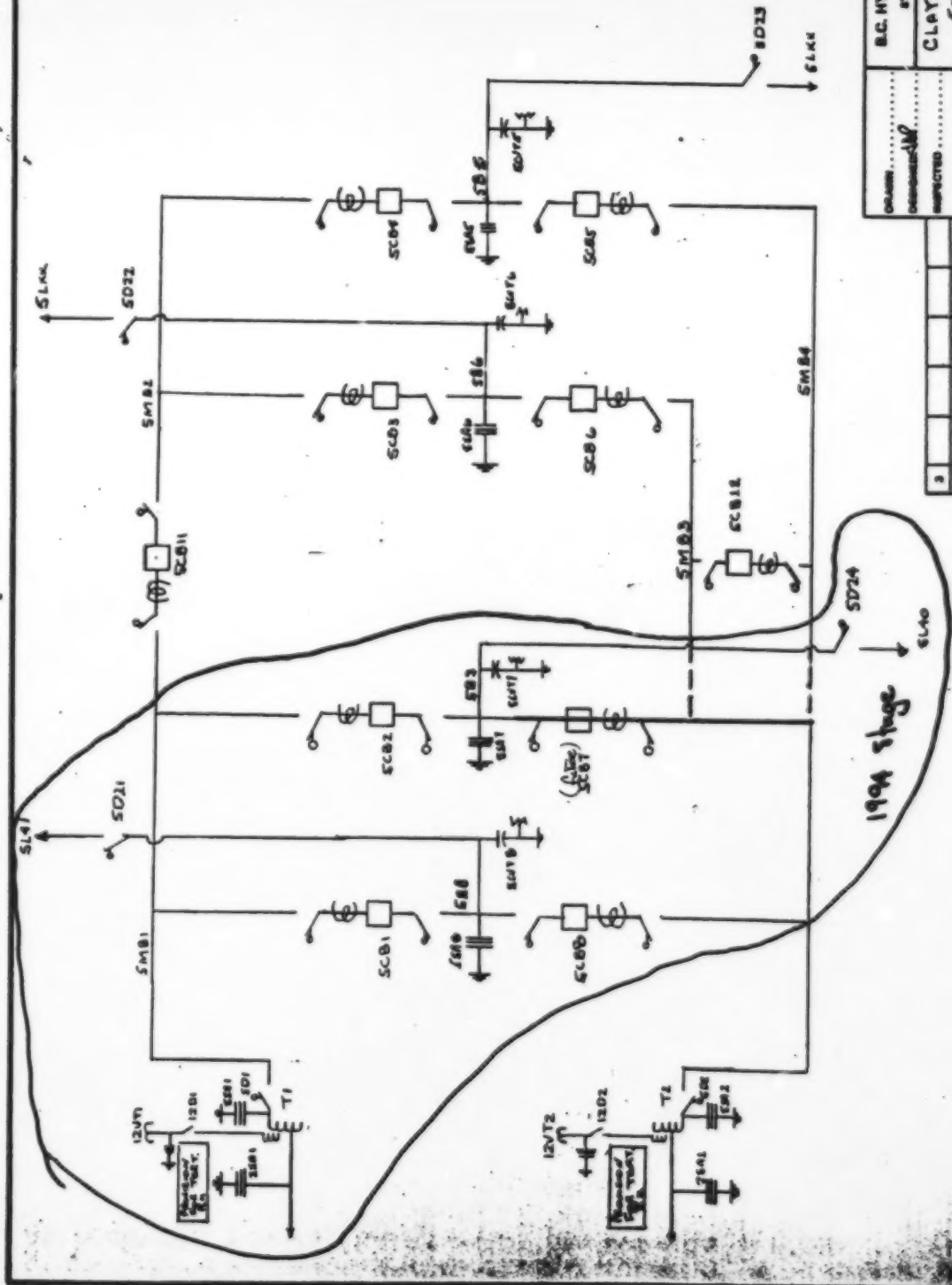
SK-CBN-ULT	Clayburn (CBN) 500kV - One Line Diagram - Ultimate Stage - 4 x 6 Alt.
SK-CBN-94	Clayburn (CBN) 500kV - One Line Diagram - 1994 Stage - 4 x 6 Alt.
SK-CBN-ULT	Clayburn (CBN) 500kV - One Line Diagram - ULT Stage - Double Bus - Double Breaker Alternative
SK-CBN-94	Clayburn (CBN) 500kV - One Line Diagram - 1994 Stage - Double Bus - Double Breaker Alternative



4x6 Alternative

B.C. HYDRO & POWER AUTHORITY SYSTEM ENGINEERING DIVISION			
DESIGNED BY	CLAYBURN (CBH)	500KV	ONE LINE DIAGRAM
INSPECTED BY	RECOMMENDED	ULTIMATE	STAGE
APPROVED BY			
DRAWN BY			
DATE	APR 15, 1991		
SHEET	1		SK - CBH - ULT

REV	NO	DATE	MADE	CHECK	RECD	APPD
3						
2						
1						



4x6 Alternative

B.C. HYDRO & POWER AUTHORITY
SYSTEM ENGINEERING DIVISION

CLAYBURN (CBL)
500KV
ONE LINE DIAGRAM
1994
STAGE

DESIGNED BY
CHECKED BY
RECOMMENDED
APPROVED

DATE APR 15, 1991

APPROVED

DATE

MADE

CHD

REC'D

APPRO

REV

NO

DATE

MADE

CHD

REC'D

APPRO

REV

NO

DATE

MADE

CHD

REC'D

APPRO

REV

NO

DATE

MADE

CHD

REC'D

APPRO

REV

NO

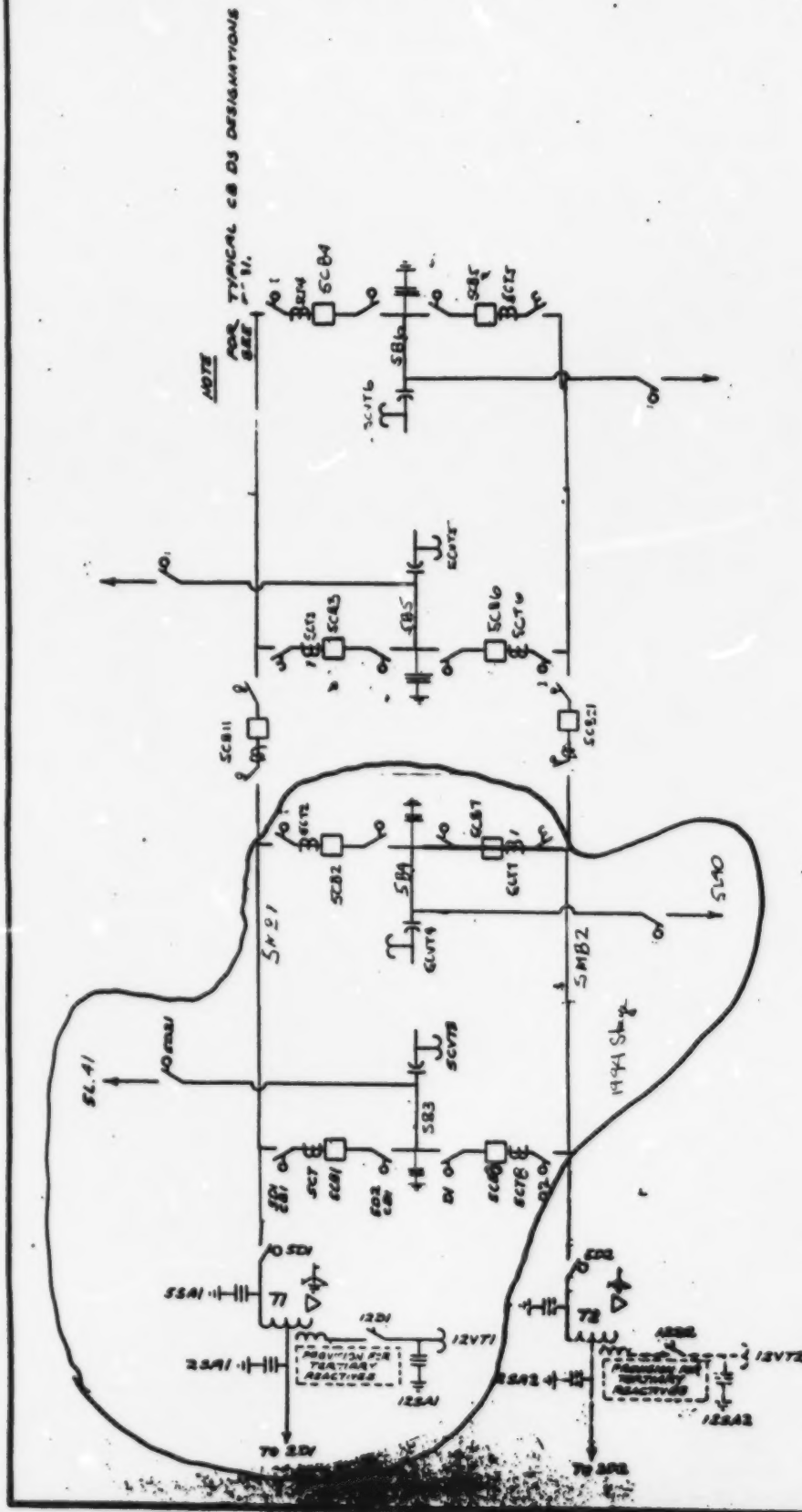
DATE

MADE

CHD

REC'D

APPRO



Double bus Double Break
 B.C. HYDRO & POWER AUTHORITY
 SYSTEM ENGINEERING DIVISION
 CLAYBURN (CBN)
 500 KV
 ONE LINE DIAGRAM
 1994 57-34

DESIGNED	7/97
CHECKED	7/97
APPROVED	7/97

REV	DATE	MADE	CHKD	APPR
1				
2				
3				
4				
5				
6				
7				
8				
9				
10				

SHEET 5K-CBN-94

APPENDIX B
DETAILS OF CIRCUIT 5L41

Contents

B.C. Hydro Dwg. 5L41-T10-B10M	Kelly Lake x Ingledow, Circuit 5L41, Circuit Details
B.C. Hydro Dwg. 5L41-T10-B11M	Kelly Lake x Ingledow, Circuit 5L41, Adjacent Circuit Separation

FROM KELLY LAKE SUBSTATION TO INGLEDOW SUBSTATION

CIRCUIT No. 5L41

ENERGIZED AT 500 KV

CIRCUIT LENGTH 320.2

MS

DESIGN DATA

LOCATION	CONDUCTOR		GROUNDWIRE		AVG. COND. HT (m) @ 50°C [STANDARD DEVIATION]	CONFIGURATION TYPE		CONDUCTOR AND GROUNDWIRE CONFIGURATION TYPE DETAIL		STRUCTURES		TERRITORY
	LENGTH (m)	DESCRIPTION	DESCRIPTION	DESCRIPTION		WOOD	STEEL			TYPE	QTY.	
KELLY LAKE - 377/5	0.09	1167.2 mm ² , 91/0, ASC, SPECIAL	9.1 mm DIA, 7W	STEEL GRADE 180	24.9 [0.0]		A	A	1 8.9 8.9	STEEL	1	SD 29
377/5 - 378/2	1.00	316.1 mm ² , 48/7, ACSR, PEACE	9.1 mm DIA, 7W	STEEL GRADE 180	22.8 [1.0]		B	B	9.5 9.5	STEEL	3	SD 30
378/2 - 461/1	133.66	316.1 mm ² , 48/7, ACSR, PEACE			23.7 [6.5]		C	C	9.5 9.5	STEEL	363	SD 32
461/1 - 461/2	1.12	838.8 mm ² , 60/37, ACSR, COTTONWOOD			67.5 [0.0]		D	D	6.2 6.2	STEEL	1	KENT DISTRICT MUNICIPALITY WITHIN SD 76
461/2 - 473/4	18.82	316.1 mm ² , 48/7, ACSR, PEACE 5005			27.6 [11.8]		C	C	11.6 11.6	STEEL	49	CHILLIWACK DISTRICT MUNICIPALITY WITHIN SD 33
473/4 - 474/2	1.46	337.9 mm ² , 24 HS/7E, ACSR, MICA 6101			40.6 [0.0]		C	C	0.46 0.46	STEEL	1	REMAINDER OF SD 33
474/2 - 518/4	72.33	316.1 mm ² , 48/7, ACSR, PEACE 5005			24.1 [8.0]		C	C	12.4 12.4	STEEL	192	ABBOTSFORD DISTRICT MUNICIPALITY WITHIN SD 34
518/4 - 574/4	90.08	316.1 mm ² , 48/7, ACSR, PEACE			17.2 [2.7]		C	C	0.46 0.46	STEEL	305	MATSOUT DIST. MUNICIPALITY WITHIN SD 34
574/4 - 575/5	1.08	316.1 mm ² , 48/7, ACSR, PEACE			18.6 [1.0]		B	B	15.2 15.2	STEEL	6	LANGLEY DIST. MUNICIPALITY WITHIN SD 35
575/5 - INGLEDOW	1.11	1167.2 mm ² , 91/0, ACSR, PEACE	9.1 mm DIA, 7W	STEEL, GRADE 180	16.9 [0.0]		A	A	0.91 0.91	STEEL		CITY OF LANGLEY WITHIN SD 35
			9.1 mm DIA, 7W	STEEL, GRADE 180								WITHIN SD 35
												CITY OF LANGLEY WITHIN SD 35
												WITHIN SD 35
												SURREY DIST. MUNICIPALITY WITHIN SD 36

REFERENCE DRAWINGS

ADJACENT CIRCUIT SEPARATION ENG. NO. 5L41-110-811M

SECTION LENGTH 518/4-574/4 REVISED

CONDUCTOR TYPE REVISED

FOR SEABIRD ISLAND TOWNS 507/4-513/5

1-11-68 521/36 ADDED 9 AMMIS RD.

1-11-68 REVISED & REDRAWN

REVISIONS

MADE CHD SUBD APPD INSP INSP DATE

SEAL

SUBMITTED R.L.

INSPECTED B.C.

INSPECTED

CHECKED DRAFTING

CHECKED DESIGN

APPROVED J.C.S.

DATE 1969

SCALE

1" = 100'

DATE

1969

SCALE

1" = 100'

DATE

TRANSMISSION ENGINEERING DIVISION

KELLY LAKE - INGLEDOW, 500 KV T/L

CIRCUIT DETAILS

SCALE

1" = 100'

DATE

1969

FUNCTIONAL CODE

7.01

DATE

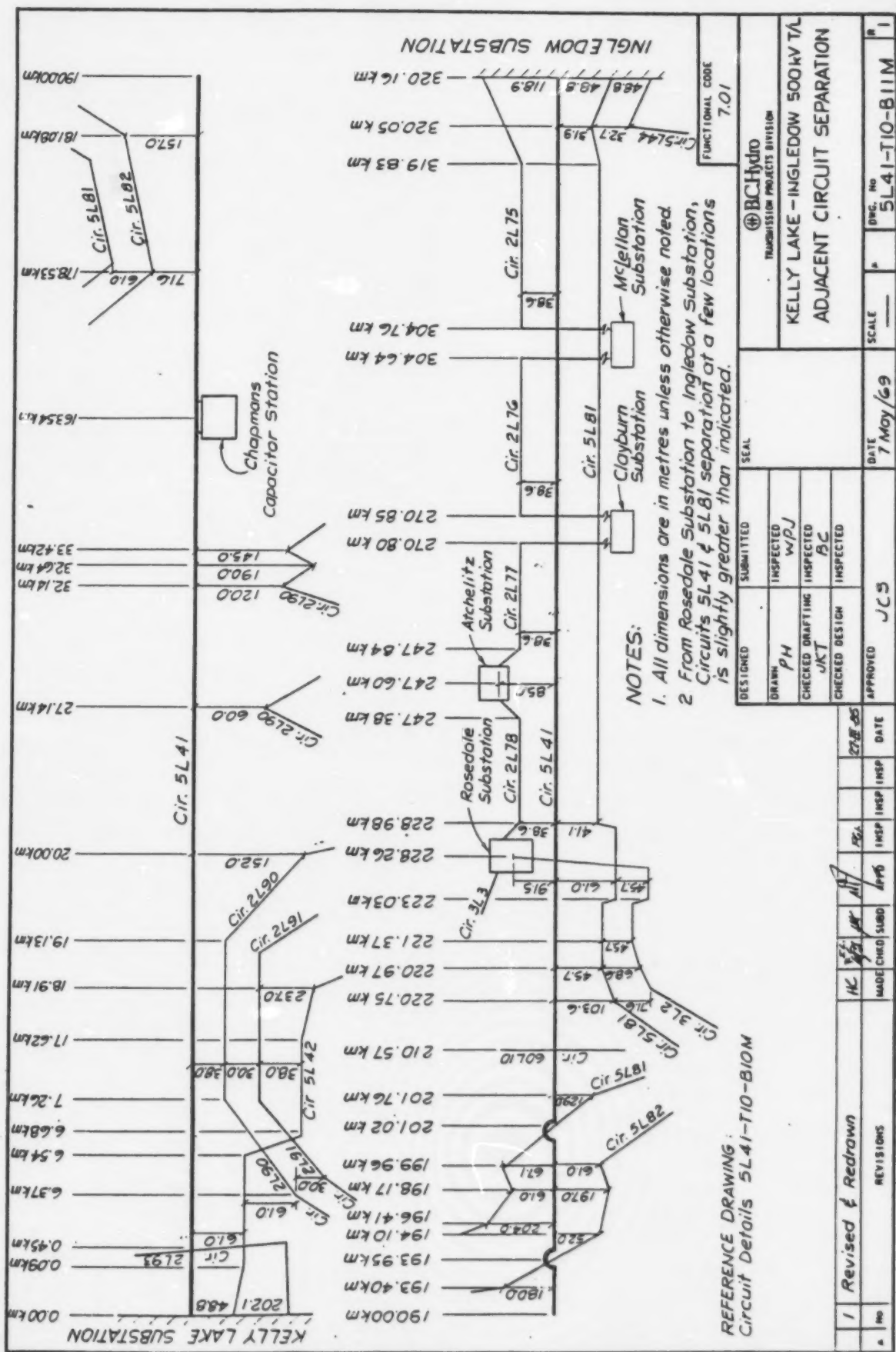
1969

SCALE

1" = 100'

DATE

1969



NOTES:
 1. All dimensions are in metres unless otherwise noted.
 2. From Roseale Substation to Ingledow Substation, Circuits 5L41 & 5L81 separation at a few locations is slightly greater than indicated.

REFERENCE DRAWING:
 Circuit Details 5L41-T10-B10M

DESIGNED		SUBMITTED		SEAL		FUNCTIONAL CODE	
DRAWN		INSPECTED		SEAL		7.01	
PH		W/PJ		BCHydro		TRANSMISSION PROJECTS DIVISION	
CHECKED DRAFTING		INSPECTED		KELLY LAKE - INGLEDOW 500kV T/L			
JKT		AC		ADJACENT CIRCUIT SEPARATION			
CHECKED DESIGN		INSPECTED		DATE			
APPROVED		JCS		7 May/69			
SCALE		BNG. NO.		5L41-T10-B10M			
REVISED & REDRAWN		REVISIONS		1			

APPENDIX C

CONSTRUCTION WORK FORCE AND EQUIPMENT SUMMARY

Contents

- C.1 - Fraser Valley System Reinforcement, Clayburn Substation and 500 kV Transmission Line Loop - Labour Force and Construction Equipment Summary**

PROJECT COMPONENT	500kV Substation			500kV Transmission Loop and Addition of Groundwires		
CONSTRUCTION YEAR	1993	1993/94	1994	1994	1994	1994
ACTIVITIES	Site Preparation	Civil Construction	Electrical Construction	Foundation Installation	Tower Erection, Modifications and Conductor installation	
CONTROLLING ORGANIZATION	B.C. Hydro					
ORGANIZATION DOING WORK	Contractors			Contractor/ B.C. Hydro forces		
PEAK MAN-POWER (A)	7	9	11	10	15 to 20	
SKILLS (B)	Equipment operators, Surveyors, labourers, teamsters, inspectors	Equipment operations, carpenters, labourers, surveyors, steel erectors, teamsters, concrete workers, building trades, inspectors	Wiremen, linemen, equipment operators, equipment testers, inspector	Piledrivers, labourers, equipment operators, surveyors, teamsters, carpenters, inspector	Liaisons, steel erectors, labourers, equipment operators, teamsters, inspector	
EQUIPMENT	Buildozers, excavators, dump trucks	excavators, dump trucks, concrete transit mixers, graders, lowbeds, flatdeck trucks, pick-ups	heavy load transporter truck, small, medium and large cranes, flat deck trucks, pick-ups, man-lifts	Pile driver, dump trucks, flat deck trucks, excavators, backhoes, pick-ups	Medium and large cranes, flat deck boom trucks, tractor/haulers, pulper, tensioner, pick-ups	
PRINCIPAL ACTIVITY CENTRES (C)	Abbotsford/ Matsqui and area surrounding Clayburn Substation					
PROBABLE ACCOMMODATION	Hotels/motels for workers outside local area, otherwise own accommodation					
TRAFFIC PATTERNS	Hwy. #1 and #11, Valley Road for access to the substation site and a major portion of the transmission loop. In addition McCallum, McLure and Gladwin Roads will be used to access the balance of transmission loop and existing towers.					
ESTIMATED DURATION (MON)	2	4	3	1	1	
NOTES:	FRASER VALLEY SYSTEM REINFORCEMENT CLAYBURN SUBSTATION AND 500KV TRANSMISSION LINE LOOP - LABOUR FORCE AND CONSTRUCTION EQUIPMENT SUMMARY					
A) Total contractor and B.C. Hydro field personnel. B) Does not reflect union affiliation. C) Other minor centres may be affected. D) See Project Schedule for activity duration and period of effort.	APPENDIX C - TABLE					

APPENDIX D

MATSQUI'S LEACHATE CONTROL SYSTEM AT CLAYBURN

Contents

- D.1 - The Corporation of the District of Matsqui, Valley Rd. Landfill Site, Leachate Control System

THE CORPORATION OF THE DISTRICT OF MATSQUI
 VALLEY RD.
 LANDFILL SITE
 LEACHATE CONTROL SYSTEM

M-373

TYP BERM SECTION A-A



SCALE 1"=100'

APPENDIX E

TECHNICAL EVALUATION CRITERIA AND EVALUATION TABLES

Contents

E.1 - Substation Technical Evaluation

E.1.1 - Substation Evaluation Criteria

Table E.1 - Substations Technical Evaluation Summary Table

E.2 - Transmission Technical and Security Evaluation

E.2.1 - Transmission Technical Evaluation Criteria

Table E.2A - Transmission Technical Evaluation Criteria Table

Table E.2B - Transmission Technical Evaluation Summary Table

E.2.2 - Transmission Security Evaluation Criteria

Table E.2C - Transmission Security Evaluation Criteria Table

Table E.2D - Transmission Security Evaluation Summary Table

APPENDIX E - TECHNICAL EVALUATION CRITERIA AND EVALUATION TABLES

E.1 SUBSTATION TECHNICAL EVALUATION

E.1.1 Substation Evaluation Criteria

The methodology for evaluating and making comparisons of substation sites for the Fraser Valley Reinforcement encompasses analysis of such components as size, staging of installations, topography, soils including ground resistance, access and special considerations. These evaluation components are described in more detail below and the evaluation and cost summary of each station site are outlined on Table E.1.1 following the evaluation descriptions.

1. Station Sizing Requirements - The size of a station is dictated by the number of transformer positions and line terminations and the voltage classes. The location of the station relative to other utility plant dictates planning requirements and thus the make up of the station. Site restrictions such as adjacent development, topography and orientation to suit transmission requirements physically impact size requirements.
2. Staging of Installations - Initial property requirements are based on the ultimate station development. The initial station development will be a portion of the planned ultimate station. Allowances must be made for temporary connections and possible changes in future requirements.
3. Topography - Stations generally require levelled areas for location of equipment, structures and buildings. Steep natural terrain and extensive drainage will increase the site development costs.
4. Soils - In areas of soils with poor bearing capacity special foundation work such as piles or preloading may be required to support the station equipment thus adding to the site development cost. In addition, soil resistivity measurements must be within a range that will provide the required electrical grounding parameters for the station. Special grounding facilities if required will add to the site development costs.
5. Access - Railway access to the site or vicinity and roadways capable of bearing heavy loads are required for station construction and transport of electrical equipment. Power transformers for this class of station could have a shipping

6. **Special Considerations** - This includes items such as special screening and or architectural features to control visibility or noise because of proximity to built-up areas. Non standard or compact designs to accommodate any site restrictions are also considered. Special considerations required for any site would normally add to the site development costs.

Table E.1 - Substation Technical Evaluation Summary Table

Evaluation Component	McLellan Substation	Clayburn Substation	Atchelitz Substation
Size	H	M	L
Staging	L	L	L
Topography	M	H	L
Soils (see note 2)	H	H	H
Access	M	L	L
Special Considerations	H	M	M

Notes:

1. L - Low, no design problems
M - Moderate, some complication or unknowns
H - High, Significant problems.
2. The soils evaluation given is assumed pending on-site soils and ground resistivity measurements.

E.2 TRANSMISSION TECHNICAL EVALUATION

E.2.1 Transmission Technical Evaluation Criteria

Each of the four evaluation components of the Technical Evaluation Table, Table E.2A follows:

1. Design - There are three independent considerations in the design components. Each was rated according to the consideration warranting the most severe rating. These considerations are:
 - a. Topography - The more severe the sideslope the more difficult and expensive the line is to construct. Taller structures are necessary or structure spacing is reduced and as a result more structures are required. Structure sites need more preparation such as benching.
 - b. Loading - The more severe the anticipated conductor ice and wind loadings are, the more structures are required to support the weight of the conductor which results in greater cost.
 - c. Percentage of Deflections - Deflections are where the line changes direction. When greater than a few degrees result in more complex structures so that the relative cost increases and security is somewhat lowered because structures are more heavily loaded.
2. Access - The ratings for access reflect the availability of roads for the construction and maintenance of the line. An area where good access already exists from linear development such as other transmission lines, pipelines or highways and other roads will warrant a low rating. The ratings will increase as the availability of existing roads decreases and as new access becomes increasingly difficult to construct. Regions where linear access is available but where access to individual structure sites would be difficult also get a high rating.
3. Clearing - The ratings for the clearing component increase as the difficulty and cost of clearing the right-of-way increases. Areas that cannot be cleared by machinery due to their sensitivity to erosion, steep slopes, poor drainage and wet lands, or final appearance and which must be cleared by hand held equipment are given high ratings.
4. Special Considerations - This includes items such as long spans, conflict with

		RATINGS				
		LOW EXTREME				
EVALUATION COMPONENTS	DESIGN CONSIDERATIONS	I	II	III	IV	V
	- Topography - Conductor Loading - Deflections	- no sidehill - light loading - low percent of defl	- rolling, some sidehill - light loading - medium percent of defl	- 30° average sidehill - medium loading - med-high percent of defl	- over 30° average sidehill - high loading - high percent of defl	- extreme sidehill - extreme loading - individual site selection
	ACCESS	Good existing access from other linear developments	Access to R/W at frequent points not far from existing roads. New road construction easy	Some access; new road construction possible	No existing access; new road construction difficult	Inaccessible to vehicles
	CLEARING	Little clearing; range land with scattered individual trees	Easy machine clearing	Moderate machine clearing; some hand clearing	Extensive hand clearing; forests that will not be logged	Totally hand clearing; steep, densely forested slopes
	SPECIAL CONSIDERATIONS	None	minimal	moderate	high	extreme

FRASER VALLEY SYSTEM REINFORCEMENT PROJECT

TRANSMISSION TECHNICAL EVALUATION CRITERIA TABLE

TABLE E.2.A

existing facilities, special designs, poor soils or anything else that would warrant specialized construction.

Table E.2B - Transmission Technical Evaluation Summary Table

Evaluation Component	McLellan Substation		Clayburn Substation	Atchletiz Substation
	Alt. "A"	Alt. "B"		
Design - Topography	I	I	I	I
Design - Loading	II	II	III	III
Design - Percent. of Deflections	V	IV	IV	I
Access	III	III	III	I
Clearing	II	I	I	I
Special Considerations	IV	V	V	III

E.2.2 Transmission Security Evaluation Criteria

Table E.2C outlines the six major hazards considered in evaluating the security of the transmission line route. Each hazard has five ratings ranging from zero to extreme depending upon the criteria described in the table. Each of the alternatives has been evaluated for all of these security hazards on an overview basis. The security hazard rating for any route alternative cannot be arithmetically derived from the ratings. This is due to the varying relative significance and unrelated nature of the six listed hazards. The assessment of the security of the route alternatives was based on engineering judgement and experience.

A brief description of the security hazards follows:

1. Avalanche - Snow avalanches can be a severe hazard to transmission facilities because of their high velocities, high impact pressures and associated air blasts and debris carrying characteristics. Hazards of this type does not exist for any of the alternatives.
2. Slope Failure - There are numerous types of slope failures which cause damage to a transmission line. These can include large scale rock and earth slides, debris flows and small scale slope failures usually affected by construction or logging activities. Areas with high local relief and abundant precipitation are particularly susceptible to slope failures. Slope failures can also occur on gentle slopes underlain by sensitive materials such as marine sediments and clayey till.

Large scale landslides must be avoided by transmission line construction because the poles or towers embedded in a landslide may undergo adverse destructive stresses. Also, access road construction and clearing may aggravate the soils movement because of reduced strength of the landslide material and disrupted drainage. These activities may also cause small scale slope failures on previously stable ground underlain by sensitive silts and clays.

Debris flows which involve the rapid downslope movement of water saturated soil and forest debris are particularly destructive to transmission lines. These are caused by the failure of a thin surface layer of water saturated soil on weathered and broken rock on steep slopes of approximately 35 degrees or greater in areas of high intensity rainstorms. Slopes susceptible to this type of failure should be avoided or special care taken in the construction and clearing activities.

3. Floods and River Erosion - Flooding and river erosion rank high in their

	SLOPE FAILURE				
	I ZERO - VERY LOW	II LOW	III MODERATE	IV HIGH	V EXTREME
AVALANCHE	LITTLE SNOW ACCUMULATION SLOPES < 10 - 15. TREE COVERED REMOTE POSSIBILITY OF OCCURRENCE	SNOW ACCUMULATION < 1.5 - SLOPES < 10 OR > 35 NO EXISTING AVALANCHE PAIRS. POSSIBILITY OF OCCURRENCE ON OPEN SLOPE DURING UNUSUALLY HEAVY SNOW FALL	STARTING ZONE: - SNOW DEPTH > 1.5 - SLOPE ANGLE 10 - 35 - TREE COVERED A FEW CONFIRMED AVALANCHE PAIRS. POSSIBILITY OF SPREADING OR PASSING NEAR ENDS OF MOUNT ZONES	STARTING ZONE: - SNOW DEPTH > 1.5 - SLOPE ANGLE 10 - 35 - DATE OF TREES NUMEROUS, CONFIRMED AVALANCHE PAIRS AT LEAST ONE LARGE AVALANCHE/PAIR AVOIDANCE OF MOST PAIRS DIFFICULT	STARTING ZONE: - SNOW DEPTH > 1.5 - SLOPE ANGLE 10 - 35 - DATE OF TREES NUMEROUS, INTERFERING OR UNCONFIRMED AVALANCHE PAIRS. MORE THAN ONE LARGE AVALANCHE/PAIR. NO POSSIBILITY OF SPREADING OR AVOIDING PAIRS.
EARTHFLOW	FLAT TO MODERATE TERRAIN WELL DRAINED, GENERALLY HOMOGENEOUS MATERIAL OR BEDROCK	FLAT TO MODERATE TERRAIN. FLOOD PLAIN, FAR OR BELT. GENERALLY WELL DRAINED BUT MATERIAL LOCALIZED AREAS OF POOR DRAINAGE.	WELLY, GLACIATED TERRAIN-NUMEROUS LARGE, MEANDERING STREAMS. UNSTABILIZED MATERIALS. DRAINAGE GENERALLY POOR. EXISTING FAILURES SMALL.	WELLY, GLACIATED TERRAIN. OLD LANDSLIDE DEPOSITS, INTERGLACIAL MATERIALS OF HIGHLY VARIOUS PERMEABILITY. POOR DRAINAGE. SLOPES MODERATE TO STEEP. SOME LARGE EXISTING FAILURES.	AREA OF EXTENSIVE, RECENT LANDSLIDE ACTIVITY. CHARACTERIZED BY TENSIVE CRACKS, BLOCKED DRAINAGE, AERIAL TRENCHES AND HUMmockS AROUND. MATERIAL CONTAINS FINE GRAINED SILT AND CLAY OR OVERLIES SHALE. AREA CANNOT BE AVOIDED.
DEBRIS (MUD) SLIDE	TERRAIN FLAT TO GENTLY ROLLING THICK SOIL MATERIAL WELL DRAINED. LIGHT RAINFALL OR SNOWMELT.	FLAT TO MODERATE TERRAIN WITH SLOPES < 35. THIN MANTLE OF SOIL OVERLYING BEDROCK. LIGHT RAINFALL AND SNOWMELT.	STEEP TERRAIN WITH SLOPES > 30° THIS MANTLE OF SOIL OVERLYING BEDROCK. POOR DRAINAGE. AREA SUBJECT TO HIGH INTENSITY RAINFALL AND SNOWMELT. RECOVER RECENTLY REMOVED OR SOIL MANTLE DISTURBED. NUMEROUS PREVIOUS SLIDES VISIBLE.	STEEP TERRAIN WITH SLOPES > 30° THIS MANTLE OF SOIL OVERLYING BEDROCK. POOR DRAINAGE. AREA SUBJECT TO HIGH INTENSITY RAINFALL AND SNOWMELT. RECOVER RECENTLY REMOVED OR SOIL MANTLE DISTURBED. NUMEROUS PREVIOUS SLIDES VISIBLE.	STEEP TERRAIN WITH SLOPES > 30° THIS MANTLE OF SOIL OVERLYING BEDROCK. POOR DRAINAGE. AREA SUBJECT TO HIGH INTENSITY RAINFALL AND SNOWMELT. RECOVER RECENTLY REMOVED OR SOIL MANTLE DISTURBED. NUMEROUS PREVIOUS SLIDES VISIBLE.
ROCKFALL	FLAT TO GENTLY ROLLING TERRAIN. UNCONSOLIDATED MATERIAL AND GENTLY ROLLING BEDROCK AREAS.	GENTLY ROLLING TERRAIN WITH MODERATE SLOPES CONSISTING OF MASSIVE DISCONTINUOUSLY JOINED ROCK NOT SUSCEPTIBLE TO EROSION.	STEEP ROCK SLOPES > 30°. FAVOURABLE ORIENTATION OF JOINTS AND BEDDING. FEW FRESH TO CRACKS AND CHALKS. SLOPE NOT UNDERCUT BY RIVER OR EROSION ETC. SOME PREVIOUS POSSIBILITY OF AVOIDING EXISTING ROCKFALLS.	STEEP ROCK SLOPES > 30°. DOWN-SLOPE ORIENTATION OF JOINTS AND BEDDING. NUMEROUS FAULT ZONES AND EXISTING ROCKFALLS. SLOPE UNDERCUT BY RIVER OR EROSION ETC. SOME PREVIOUS POSSIBILITY OF AVOIDING EXISTING ROCKFALLS.	STEEP ROCK SLOPES > 30°. DOWN-SLOPE ORIENTATION OF JOINTS AND BEDDING. NUMEROUS FAULT ZONES AND EXISTING ROCKFALLS. SLOPE UNDERCUT BY RIVER OR EROSION ETC. SOME PREVIOUS POSSIBILITY OF AVOIDING EXISTING ROCKFALLS.
FLOOD AND RIVER EROSION	FLAT TO GENTLY ROLLING TERRAIN. A FEW WELL COVERED AREAS WITH REMOTE POSSIBILITY OF FLOODING OR COURSE CHANGE.	MODERATE TO STEEP TERRAIN. FEW INTERSECTING STREAMS WITH SOME POSSIBILITY OF FLOODING OR COURSE CHANGE.	ONLINE CROSSING OF WIDE FLOODPLAIN OF MAJOR CREEK OR RIVER. SOME FLOODING. A FEW SOME INTERSECTING STREAMS PRONE TO FLOODING OR COURSE CHANGE. SOME POSSIBILITY OF AVOIDANCE.	LINE LOCATED ON FLOODPLAIN. NUMEROUS TERRAIN PRONE TO HIGH INTENSITY RAINFALL AND SNOWMELT. RIVER CHANNEL GENERALLY CONFINED BUT PRONE TO COURSE CHANGE. LINE CROSSED ROUTING OF SOME FLOODS SUBJECT TO FLOODING OR COURSE CHANGE.	LOCATED ON FLOODPLAIN. NUMEROUS TERRAIN PRONE TO HIGH INTENSITY RAINFALL AND SNOWMELT. RIVER CHANNEL GENERALLY CONFINED BUT PRONE TO COURSE CHANGE. LINE CROSSED ROUTING OF SOME FLOODS SUBJECT TO FLOODING OR COURSE CHANGE.
ICE AND WIND LOADING	COMPLETELY SHIELDED. AIR MASSSES GENERALLY HOT. TEMPERATURES RARELY BELOW FREEZING.	GENERALLY UNSHIELDED AND AT LOWER ALTITUDES. SOME EXPOSURE TO MOIST AIR. PERIGRAPHIC TEMPERATURES BELOW FREEZING.	GENERALLY EXPOSED TO PREVAILING WINDS AND/OR MOIST AIR MASSSES. SUSTAINED TEMPERATURES BELOW FREEZING.	MOIST EXPOSED TO PREVAILING WIND MASSSES. SUSTAINED TEMPERATURES BELOW FREEZING. LINE ORIENTED OR PARALLEL TO PREVAILING WIND A GENERALLY ABOVE TREELINE OR AREA PRONE TO ENTRAPMENT OF COLD ARCTIC AIR BY MOIST COASTAL AIR.	COMPLETE TRANSVERSE EXPOSURE TO HIGH VELOCITY, PREVAILING WIND. MOIST AIR MASSSES AND FREEZING. TEMPERATURES BELOW FREEZING.

FRASER VALLEY SYSTEM REINFORCEMENT PROJECT

TRANSMISSION SECURITY EVALUATION CRITERIA TABLE

TABLE E.2.C

destructive capability to transmission lines. Flood waters can undermine poles or towers or cause damage with floating logs and debris unless adequate protection measures are installed. River banks can erode hundreds of metres in a single flood and small creeks can become raging torrents in a few hours during heavy rainstorms and during snowmelt.

Securing structures against flood and erosion damage can be difficult, expensive and environmentally undesirable. Typical security methods include surrounding structures with a sheet piled wall filled with rock, pile/ caisson footings, rip-rap, dykes and diversion or modification of stream channels.

4. Ice and Wind Loading - Significant consideration is given to ice and wind loading during transmission design and route location. Ice accumulation and wind loading can cause collapse of structures and breakage of conductors and hardware. Ice accumulation on insulators can cause faults and short term outages.

Large amounts of ice can form when fog or clouds pass slowly by structures and conductors at temperatures well below freezing or when moisture is deposited by freezing rain or drizzle in conjunction with high wind velocities and freezing temperatures.

Strong winds and gusts can cause damage by imposing high loads on structures and conductors either by direct force or by setting the conductor in motion causing circuit interruptions due to contact between conductors or with the structure by causing suspension insulator strings to swing beyond their expected angle. Severe ice and wind loading can occur simultaneously and their combined effect can be devastating to transmission structures.

The meteorological phenomena of ice and wind loading is complex and areas prone to such conditions are difficult to outline without long-term measurement and testing. However, certain terrain features and ambient air temperatures exercise considerable influence on the phenomena. Areas to avoid in transmission line construction are exposed ridges and narrow passes at high elevations where wind speeds are high and where passing clouds can envelope the structures. In coastal areas susceptible to cold northern air masses severe ice and wind conditions can occur at considerably lower elevations particularly where warm air can mix with or be trap colder air in depressions and valleys.

Protection against ice and wind loading is restricted to installing stronger structures and conductors or reducing spans to increase factors of safety. These measures are extremely costly and complete security cannot always be assured.

structures and conductors or reducing spans to increase factors of safety. These measures are extremely costly and complete security cannot always be assured. Areas of known extreme ice and wind conditions should therefore be avoided.

Table E.2D - Transmission Security Evaluation Summary Table

Evaluation Component	McLellan Substation		Clayburn Substation	Atchletiz Substation
	Alt. "A"	Alt. "B"		
Avalanche	I	I	I	I
Slope Failure	I	I	I	I
Floods and Erosion	II	II	II	II
Ice and Wind Loading	II	II	III	III

APPENDIX F

**CLAYBURN SUBSTATION AREA - DEVELOPMENT
PERMIT AREA SPECIAL REQUIREMENTS**

H. DESIGNATION OF DEVELOPMENT PERMIT AREAS

Section 945(4) of the Municipal Act authorizes local governments to designate areas in the Official Community Plan for the

- (a) protection of the natural environment
- (b) protection of development from hazardous conditions
- (c) protection of provincial or municipal heritage sites
- (d) revitalization of an area in which a commercial use is permitted, or
- (e) establishment of objectives and the provision of guidelines for the form and character of commercial, industrial or multi-family development.

Where an area is designated, land development and construction shall only take place after a development permit has been issued by Council.

Where Council has designated lands under categories (a) and (b) above, these are the only lands so identified to date. This Plan should not be construed to mean that all other lands are free of such environmental or hazard problems.

The following development permit areas are hereby designated:

DEVELOPMENT PERMIT AREA NO. 21, as per Map M-420,
Sheet 21

Name: Willband Creek Flood Plain Development Permit
mit Area

Category: "a" (Natural Environment)
"b" (Natural Hazard)

Justification: Most of the land included in the Willband Creek Flood Plain Development Permit Area has been identified as being within the 100-year flood plain. The land contains ground water at or near the surface and is subject to periodic flooding. It functions as a natural storm water detention area and is required to remain in its natural state in order to minimize downstream flooding. As such it must remain free of further development, including any deposition of fill or other material, except where equivalent additional water storage capacity is provided by way of excavation elsewhere within the development permit area. The objective of the development permit area is to protect downstream land and development from further flooding by preserving the natural drainage characteristics that control run-off and reduce storm water volumes and velocities.

Guidelines: Development permits issued in this area shall comply with the following guidelines:

1. The deposit of soil or fill material, recontouring or building construction shall not take place where it would reduce the storm water detention capacity of the Willband Creek flood plain, as defined on Map M-420, Sheet 21.

2. No building permit shall be issued, and no land clearing, recontouring, removal of soil or vegetation, or the deposit of soil or fill material of any kind shall be carried out within the development permit area until a development permit has been issued outlining appropriate measures to preserve the storm detention capabilities of the area and to protect the creek and its flood plain from erosion, siltation, degradation and any harmful effects of adjacent development.

3. No structures or paved surfaces shall be permitted in any area subject to damage from flooding.

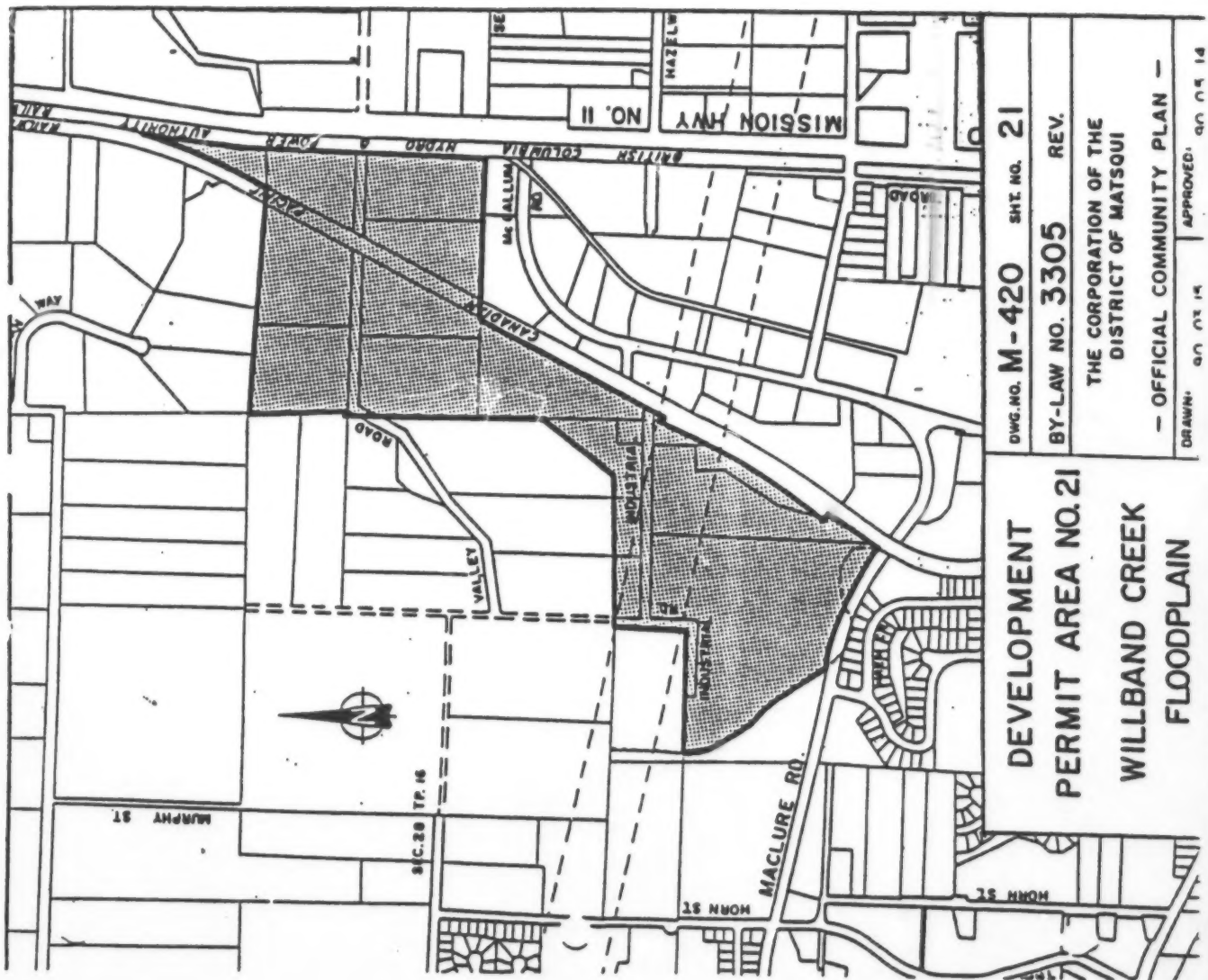
4. Buildings, structures, paved surfaces, and any underground drainage facility or tile field shall be located at such a distance from the creek and storm detention area as to minimize run-off and siltation, and the possibility of erosion or sloughing. Any necessary sediment barriers or other containment measures shall be in place at the clearing and construction stage.

5. Every application for a development permit shall be accompanied by plans showing any works and measures to be carried out under the permit to satisfy the above-mentioned objectives, which plans shall be signed and sealed by a Professional Engineer licensed to practice in the Province of British Columbia. The Professional Engineer will certify that the works and measures detailed in the plans shall be sufficient to satisfy the said objectives, shall attest that he will supervise and has been authorized by the Developer to supervise the carrying out of such works and measures to ensure that they are

carried out in accordance with the said plans and the terms of any development permit issued hereunder and, upon completion of the said works and measures and prior to the issuance of any building permit on lands which are subject to a development permit issued hereunder, shall certify that all such works and measures have been carried out in accordance with the said plans and the terms of the said development permit.

Application Submission Requirements: Every application for a development permit shall be accompanied by:

1. Plans showing works and measures to be carried out in accordance with the above-mentioned Guideline No. 5.
2. A site plan showing buildings and structures, parking areas, access and the top of the bank defining the channel of Willband Creek.
3. A plan showing existing and proposed grades.
4. A plan showing selected cross-sections through the site.
5. Other information as may be necessary to assess the development proposal.



DWC NO. M-420 SHEET NO. 21

BY-LAW NO. 3305 REV.

THE CORPORATION OF THE DISTRICT OF MATSQUI

— OFFICIAL COMMUNITY PLAN —

DRAWN: 00 02 15 APPROVED: 00 04 14

**DEVELOPMENT
PERMIT AREA NO.21
WILLBAND CREEK
FLOODPLAIN**